

# 465A AMPLIFIER

OPERATING AND SERVICE MANUAL

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HEWLETT  PACKARD

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# OPERATING AND SERVICE MANUAL

(HP PART NO. 00465-90000)

## MODEL 465A AMPLIFIER

SERIALS PREFIXED: 511-

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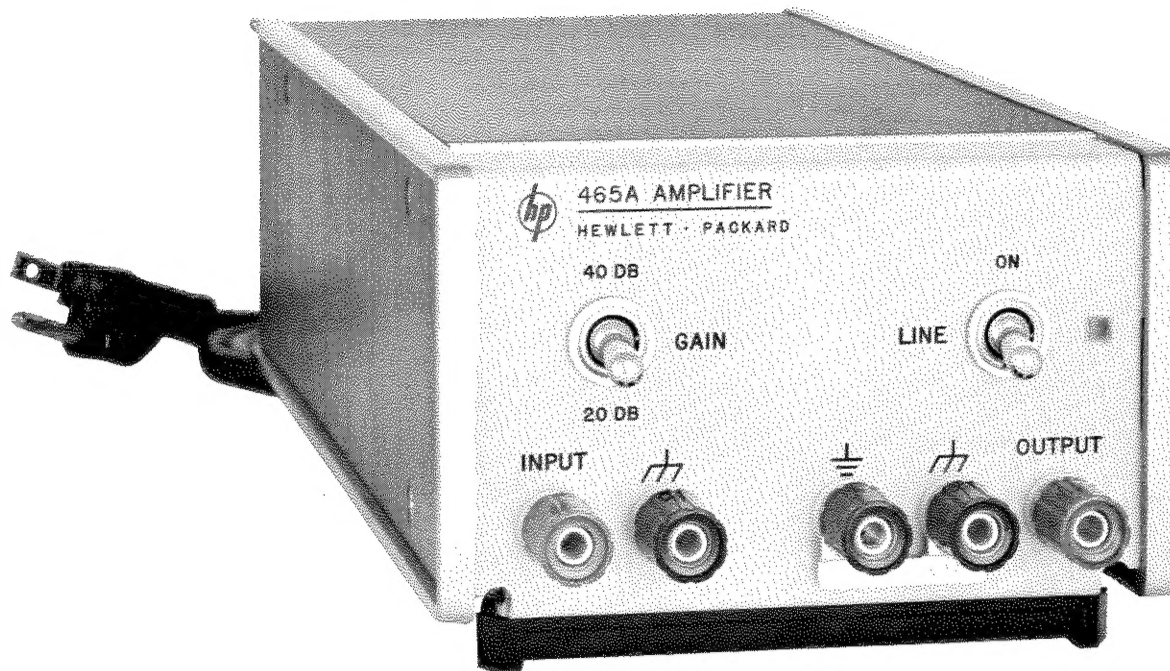


Figure 1-1. Hewlett-Packard Model 465A Amplifier

Table 1-1. Specifications

<p>Voltage Gain: 20 db (X10) or 40 db(X100), open circuit.</p> <p>Gain Accuracy: <math>\pm 0.1</math> db (<math>\pm 1\%</math>) at 1000 cps.</p> <p>Frequency Response: <math>\pm 0.1</math> db, 100 cps to 50 kc; less than 2 db down, 5 cps to 1 Mc.</p> <p>Output: greater than 5 volts rms into 50 ohms (1/2 watt); greater than 10 volts rms open circuit.</p>	<p>Distortion: 1%, 5 cps to 100 kc; 2%, 100 kc to 1 Mc.</p> <p>Input Impedance: 10 megohms shunted by <math>&lt; 20</math> pf.</p> <p>Output Impedance: 50 ohms</p> <p>Noise: not greater than <math>25 \mu\text{v}</math> rms referred to input (with 1 megohm across input).</p> <p>Weight: 3 lbs, 12 oz.</p>
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## SCOPE

This manual contains the information necessary for operating and servicing the standard Model 465A Amplifier and the Model 465A/Option 01 Amplifier (rear input connectors in parallel with front panel connectors).

## SECTION I GENERAL INFORMATION

### 1-1. DESCRIPTION.

1-2. The -hp- Model 465A is a general-purpose amplifier, and an ideal impedance converter (10 megohms to 50 ohms). This amplifier has extremely stable 20 db or 40 db gain over a continuous frequency range of 5 cps to 1 megacycle. Either gain may be selected quickly with a switch on the front panel. The output stage provides low output impedance and wide dynamic range. The -hp- 465A is a three-terminal device isolated from chassis and may be floated up to 500 volts dc above chassis ground.

### 1-3. INSTRUMENT IDENTIFICATION.

1-4. Hewlett-Packard uses a two-section, eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 465A described in this manual.

1-5. If the first three digits of the two-section, eight-digit serial number are prefixed with an E or G, your instrument was produced in Europe. An E000-00000 serial number indicates that the instrument was manufactured in England; a G000-00000 serial number indicates that the instrument was manufactured in Germany.



## SECTION II

### INSTALLATION

#### 2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 465A Amplifier. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

#### 2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks or scratches and be in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

#### 2-5. POWER REQUIREMENTS.

2-6. The Model 465A Amplifier can be operated from any source of 115 or 230 volts ( $\pm 10\%$ ), 50-1000 cps. With the instrument disconnected from the ac power source, move the slide switch (located on the rear panel) until desired line voltage appears. Power dissipation is 10 watts maximum.

#### 2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-pronged conductor cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instruments from a two-contact outlet, use a three-prong adapter and connect the green pig-tail on the adapter to ground.

#### 2-10. INSTALLATION.

2-11. The Model 465A is fully transistorized. No special cooling is required; however, the instrument should not be operated where the ambient temperature exceeds  $55^{\circ}\text{C}$  ( $131^{\circ}\text{F}$ ).

#### 2-12. BENCH MOUNTING.

2-13. The Model 465A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

#### 2-14. RACK MOUNTING.

2-15. The Model 465A may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service Office (see Appendix B for office locations).

#### 2-16. COMBINATION MOUNTING.

2-17. The Model 465A may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 11051A, 11052A, or both, depending on depth). The Combining Case is a full-module unit which accepts various combinations of submodular units. Being a full-module unit, it can be bench or rack mounted and is analogous to any full-module instrument.

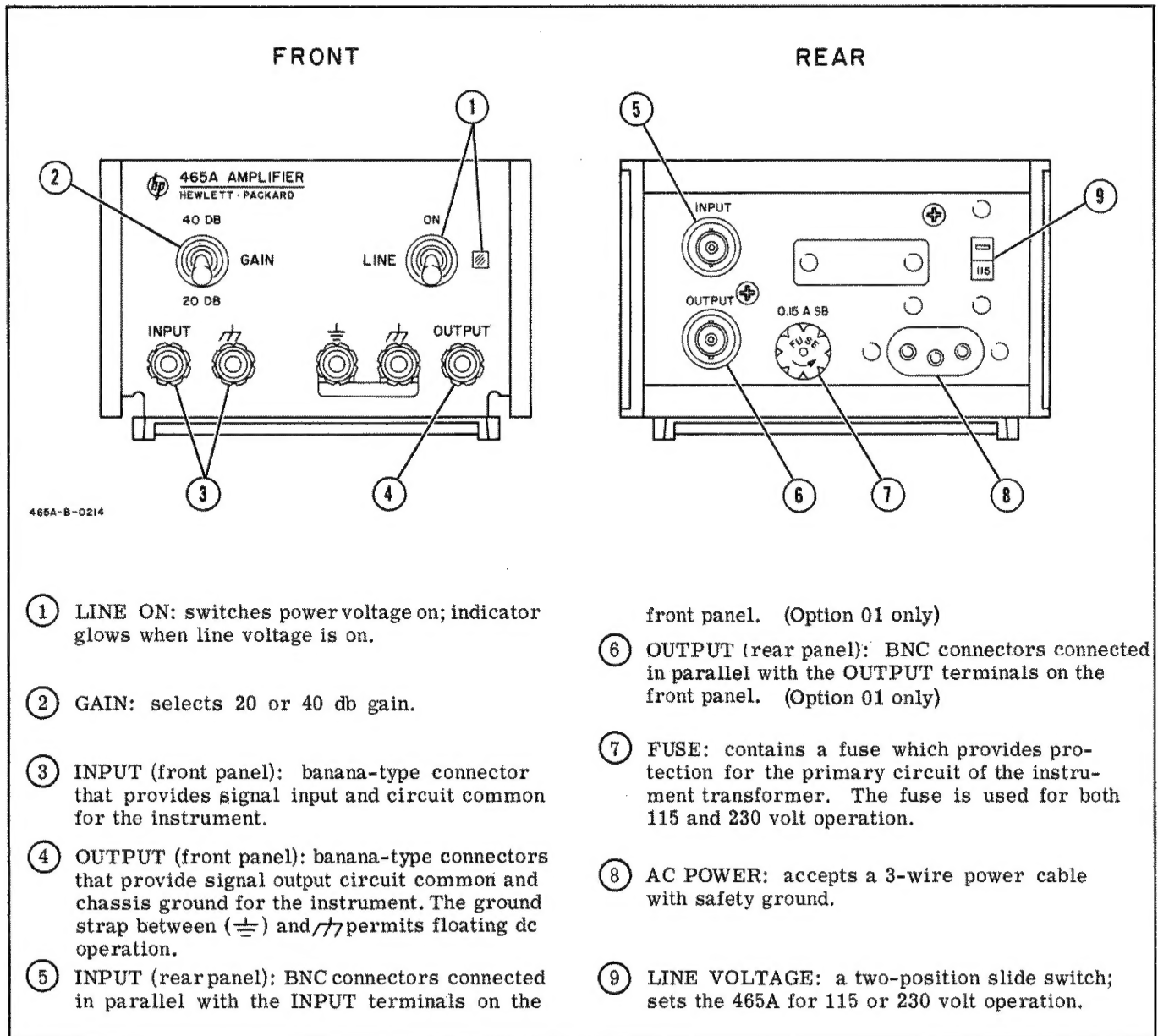


Figure 3-1. Front and Rear Panel Controls, Indicators and Connectors



## SECTION III

### OPERATING INSTRUCTIONS

#### 3-1. GENERAL.

3-2. The Model 465A Amplifier can be operated as: (1) a general purpose amplifier/preamplifier, (2) oscilloscope preamplifier, (3) oscillator power ampli-

#### CAUTION

Ensure that transients greater than  $\pm 200$  vdc or  $\pm 25$  vdc are not applied to the input or output terminals, respectively. Otherwise damage to the Model 465A may result.

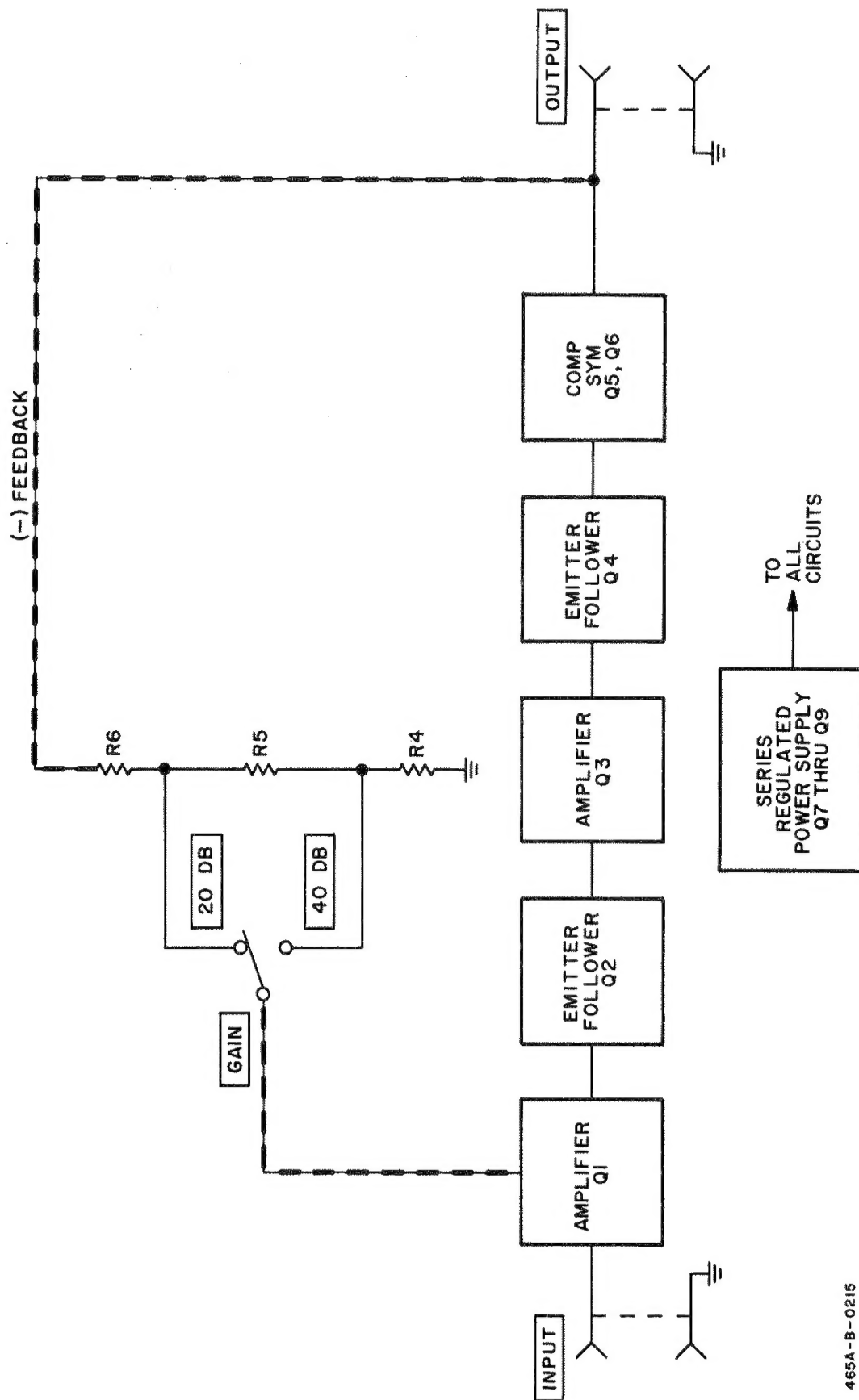
fier, (4) impedance converter ( $5 \times 10^8$  power gain) and (5) in-system amplifier unit.

#### 3-3. DESCRIPTION OF CONTROLS.

3-4. Figure 3-1 gives a description of the front panel and rear panel controls for the 465A.

#### CAUTION

Ensure that common ( $\perp$ ) terminals are connected before INPUT or OUTPUT terminals. Otherwise damage to the Model 465A may result due to transients.



465A-B-0215

Figure 4-1. Model 465A Amplifier Block Diagram

## SECTION IV

### THEORY OF OPERATION

#### 4-1. INTRODUCTION.

4-2. The -hp- Model 465A Amplifier comprises an amplifier section and a power supply section. The amplifier section contains two amplifier stages, two emitter followers and a complementary symmetry pair. The power supply is the series regulated type.

#### 4-3. GENERAL CIRCUIT DESCRIPTION.

4-4. Figure 4-1 shows the block diagram for the 465A Amplifier. Each amplifier stage (Q1 and Q3) is followed by an emitter follower (Q2 and Q4) to prevent loading of the amplifiers. The complementary symmetry pair (Q5 and Q6) provide power gain and low output impedance. Overall feedback, taken from the output and applied differentially to the initial amplification stage decreases distortion and increases gain accuracy. Resistive voltage divider (R4, R5, and R6) changes the amount of feedback to obtain 20 or 40 db gain as selected by the GAIN switch on the front panel. The regulated power supply provides a constant 45 volts to the amplifier circuitry.

#### 4-5. DETAILED CIRCUIT DESCRIPTION.

4-6. Refer to Figure 5-8 for the schematic diagram of the Model 465A Amplifier.

#### 4-7. FIRST AMPLIFICATION STAGE.

4-8. The first amplification stage comprises field effect transistor Q1 and emitter follower Q2. Q1 provides high input impedance and low input noise. Emitter follower Q2 provides isolation while driving the second amplification stage. Q2 also bootstraps Q1 load resistor R10. This permits the field effect transistor to have a gain of approximately 40 db, while operating at an optimum current (for noise) from a 45 volt power supply. C6 and R12 stabilize the overall gain. R13 and C9 allow Q2 to operate as an emitter follower with reduced operating voltage to lower the power dissipation and the noise generation. R2 and R7 set the gate voltage for Q1; Q2 bypasses any ac on the supply, preventing hum injection into Q1.

#### 4-9. SECOND AMPLIFICATION STAGE.

4-10. The second amplification stage consists of amplifier Q3 and emitter follower Q4. Amplifier Q3 is a common emitter stage. When the GAIN switch is on 20 DB, Q3 has 20 db of gain. Q1 and Q3 together give a total of 60 db gain, of which 40 db is used as feedback and 20 db is retained as the closed loop gain. When the GAIN switch is on 40 DB, C11 shunts R22, giving Q3 40 db of gain. The 40 db of feedback is still used, which allows the same gain shaping to be

used in both GAIN switch positions (20 DB and 40 DB). R19 maintains a charge on C11 (in the 20 DB position) to eliminate switching transients while changing gain. R15, R16, R17 and CR1 form the bias voltage divider for Q3, R15 provides bias adjustment and CR1 provides temperature compensation. Emitter follower Q4 isolates and drives the complementary symmetry pair Q5 and Q6.

#### 4-11. OUTPUT CIRCUITRY.

4-12. Q5 and Q6 operate as complementary symmetry emitter followers. CR2 and CR3 forward bias Q5 and Q6 to prevent cross-over distortion. R24 and R25 determine the idling current flowing through Q5 and Q6. A true 50-ohm output impedance for a proper match to the 50-ohm cable or instrument is provided by R26. C15 is the dc blocking capacitor for output; R27 keeps the output voltage at zero volts dc.

#### 4-13. FEEDBACK CIRCUITRY.

4-14. The feedback circuitry controls the amplifier gain by selecting the amount of voltage division by voltage divider R4, R5 and R6. C5 provides phase lead to improve the phase margin around 1 Mc. C4 and C14 eliminate transients during GAIN switching by preventing dc voltages from being applied to the divider stick. Negative feedback is applied to field effect transistor Q1 and differentially compared with the input, which provides improved signal reproduction.

#### 4-15. REGULATED POWER SUPPLY.

4-16. The regulated power supply provides the +45 volts used by the amplifier. A filter circuit, formed by L1, L2, C22 and C23 prevents any interference from being fed into the instrument power line. T1, CR4, CR5 and C16 form a full-wave rectifier. Diode CR6 sets a reference voltage for the emitter circuit of Q7. This reference voltage is compared to the power supply output by Q7, which amplifies the error signal to drive Q8. Transistor Q8, acting as a current amplifier, drives series regulator Q9. Q8 also improves the gain by isolating Q7. C19 and R35 provide gain shaping for high frequency stability of the power supply amplifier. C18 bootstraps R33 by driving it from the output of the regulator. This increases the voltage gain of Q7, which improves voltage regulation of the power supply. Resistors R30, R31 and R32 provide a divided dc voltage proportional to the dc output and close to the reference voltage provided by CR6. This gives Q7 its bias and reference signal, which controls the series regulator. C17 couples all ac output to Q7 to provide better ripple reduction.

Table 5-1. Test Equipment Required

Instrument	Critical Specifications	Use	Recommended Model
DC Voltmeter	Accuracy: $\pm 2\%$ Voltage Range: 50 v full scale	Performance Checks	-hp- Model 3440A/3445A AC-DC Digital Voltmeter
Test Oscillator	Frequency Range: 10 cps to 1 Mc Voltage Output: 1 v	Performance Checks	-hp- Model 651A Test Oscillator
Oscilloscope	Frequency: 2 kc Vertical Sensitivity: 10 v/cm	Troubleshooting	-hp- Model 130C Oscilloscope
AC Voltmeter	Accuracy: $\pm 1\%$ , 100 cps to 50 kc $\pm 2\%$ , 10 cps to 1 Mc Voltage Range: 10 v Frequency Range: 10 cps to 1 Mc	Performance Checks	-hp- Model 3440A/3445A AC-DC Digital Voltmeter -hp- Model 331A Distortion Analyzer
Variable Voltage Line Transformer	Voltage Range: 103.5 to 126.5 v Output Power: 10 watts	Performance Checks	Superior Electric Co. Type 3PN-116
Ohmmeter	Ohms Range: 10 M ohms	Troubleshooting	-hp- Model 3440A/3445A Multi-Function Unit
Frequency Response Test Set	Frequency: 10 cps to 1 Mc with external oscillator Voltage Output: 10 v	Performance Checks	-hp- Model 739AR Fre- quency Response Test Set
Distortion Analyzer	Frequency: 10 cps to 500 kc Sensitivity: 1% full scale	Performance Checks	-hp- Model 331A Distortion Analyzer
DC Power Supply	Voltage Output: +45 v Current Limit: 75 ma	Troubleshooting	-hp- Model 723A DC Power Supply
Resistor	1 M ohm, 1%, 1/2 w 50 ohms, 1%, 1 w 1 M ohm, shielded load	Performance Checks	-hp- Part No. 0757-0059 -hp- Part No. 0757-0024 See Figure 5-3

## SECTION V MAINTENANCE

### 5-1. INTRODUCTION.

5-2. This section contains information necessary for the proper maintenance of the -hp- Model 465A Amplifier. This section provides the necessary Performance Checks, Adjustment and Calibration Procedures, and Troubleshooting Techniques required to accomplish the above objective.

### 5-3. TEST EQUIPMENT REQUIRED.

5-4. The test equipment required to perform the operations outlined in this section is listed in Table 5-1. This table describes the type of instrument required, critical specifications, type of operation to be conducted and the recommended model. If the specific model recommended is not available, equipment which meets or exceeds the critical specifications listed may be substituted.

### 5-5. PERFORMANCE CHECKS.

5-6. The Performance Checks presented in this section are front panel procedures designed to compare the Model 465A with its published specifications. These operations may be incorporated in periodic maintenance, post-repair, or incoming quality control checks. These operations should be conducted before any attempt is made to adjust or calibrate the instrument. During these operations, the Model 465A power line voltage should be periodically varied  $\pm 10\%$ . A fifteen minute warm-up period should be allowed prior to conducting these checks.

### 5-7. ACCURACY AND GAIN CHECK.

a. A Test Oscillator (-hp- Model 651A) and an AC Voltmeter (-hp- Model 3440A/3445A) will be required for this test.

b. Set Model 465A to 20 db.

c. Connect test oscillator OUTPUT to Model 465A INPUT. Set oscillator frequency to 1 kc; adjust amplitude for 1.00 v rms output (verify with ac voltmeter).

d. Connect ac voltmeter to Model 465A OUTPUT. Voltmeter should read between 9.90 and 10.1 v. If correct, adjust oscillator output amplitude for ac voltmeter reading of 1.0 v as measured at output of 465A. This corresponds to an input of 100 mv.

e. Switch Model 465A to 40 db. AC voltmeter should read between 9.90 and 10.1 v.

### 5-8. FREQUENCY RESPONSE CHECK.

a. Figure 5-1 describes the test arrangement recommended. A Test Oscillator (-hp- Model 651A), a Frequency Response Test Set (-hp- Model 739AR) and an AC Voltmeter (-hp- Model 331A and 3440A/3445A) will be required. -hp- Model 3440A/3445A will be used for frequencies from 50 cps to 100 kc; -hp- Model 331A will be used at all other frequencies.

b. Connect Model 465A as shown in Figure 5-1. Set GAIN to 20 DB.

c. Set ac voltmeter RANGE to 10 V.

*280 mV  
p-p*

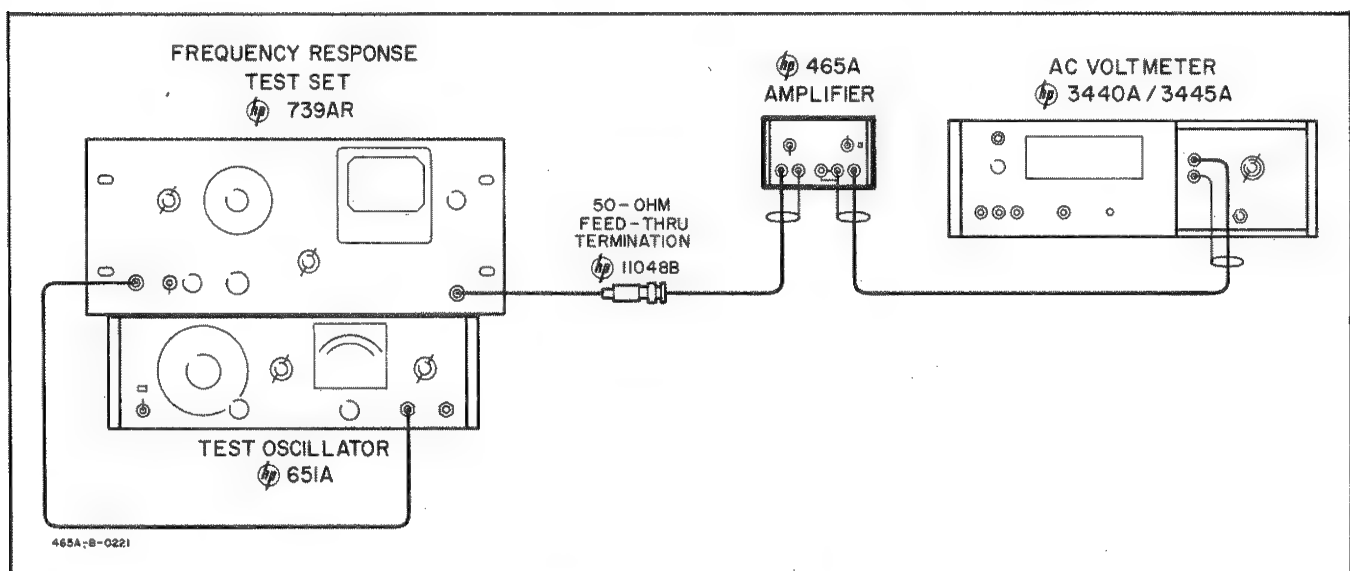


Figure 5-1. Frequency Response Check

Table 5-2. Frequency Response Test

-hp- Model 465A GAIN (db)	Oscillator -hp- Model 651A		F. R. T. S. -hp- Model 739AR Output Attenuator	AC Voltmeter -hp- Model 3440A/3445A or 331A	
	Range	Frequency (cps)		Range	Readings
20	1 K	1	1.0	10	9.0 v
20	10	1	1.0	10	08.1 to 09.9 v
20	100	1	1.0	10	08.9 to 09.1 v
20	10 K	5	1.0	10	08.9 to 09.1 v
20	1 M	1	1.0	10	7.2 to 10.8 v
40	1 K	1	.1	10	9.0 v
40	10	1	.1	10	08.1 to 09.9 v
40	100	1	.1	10	08.9 to 09.1 v
40	10 K	5	.1	10	08.9 to 09.1 v
40	1 M	1	.1	10	7.2 to 10.8 v

d. Set frequency response test set to EXTERNAL; OUTPUT ATTENUATOR to 1.0 .

e. Set oscillator frequency to 1 kc; adjust output amplitude to provide ac voltmeter reading of 9.0 v.

f. Adjust frequency response test set METER SET to convenient SET LEVEL.

g. Reset oscillator frequency to 10 cps. Adjust oscillator amplitude to re-establish SET LEVEL, if required. AC voltmeter should read between 8.1 and 9.9 v.

h. Repeat step g above for oscillator frequencies listed in Table 5-2. AC voltmeter should read within limits specified.

j. When going from 20 db to 40 db, re-adjust oscillator output for ac voltmeter reading of 9.0 v at 1 kc. Reset frequency response test set METER SET for SET LEVEL. Repeat above test using frequency settings provided in Table 5-2.

#### 5-9. INPUT IMPEDANCE CHECK.

a. A Test Oscillator (-hp- Model 651A), an AC Voltmeter (-hp- Model 3440A/3445A) and a 1 M ohm  $\pm 1\%$ , 1/2 watt resistor (-hp- Part No. 0757-0059) will be required.

b. Set Model 465A GAIN to 20 db.

c. Connect ac voltmeter to Model 465A OUTPUT. Set RANGE to 10 V.

d. Connect oscillator OUTPUT to Model 465A INPUT. Set oscillator frequency to 100 cps; adjust output amplitude for ac voltmeter reading of 10 v.

e. Insert 1 M ohm resistor in series with osci-

llator and Model 465A INPUT (resistor must be connected directly to Model 465A INPUT with nothing else across input terminals). AC voltmeter should read approximately 9.1 v ( $\pm 0.4$ v). This verifies a Model 465A input resistance of 10 M ohms.

f. Reset oscillator frequency to 10 kc. Insure that oscillator output is still 1.0 v. AC voltmeter should read more than 6.0 v. This verifies a Model 465A input impedance of 10 M ohms, shunted by 20 pf.

#### 5-10. OUTPUT IMPEDANCE CHECK.

a. A Test Oscillator (-hp- Model 651A), an AC Voltmeter (-hp- Model 331A) and a 50 ohm  $\pm 1\%$ , 1 watt resistor (-hp- Part No. 0727-0024) will be required for this test.

b. Set Model 465A GAIN to 20 db.

c. Connect ac voltmeter to Model 465A OUTPUT; set RANGE to 10 V.

d. Connect oscillator OUTPUT to Model 465A INPUT. Set frequency to 1 kc; adjust output for ac voltmeter reading of 10 v.

e. Place 50 ohm resistor across Model 465A OUTPUT. AC voltmeter reading should drop to 5.0 v. This verifies Model 465A output impedance of 50 ohms.

#### 5-11. DISTORTION CHECK.

a. Figure 5-2 describes the test arrangement recommended. A Test Oscillator (-hp- Model 651A), a Distortion Analyzer (-hp- Model 331A) and a Frequency Response Test Set (-hp- Model 739AR) will be required.

b. Connect Model 465A as shown in Figure 5-2.



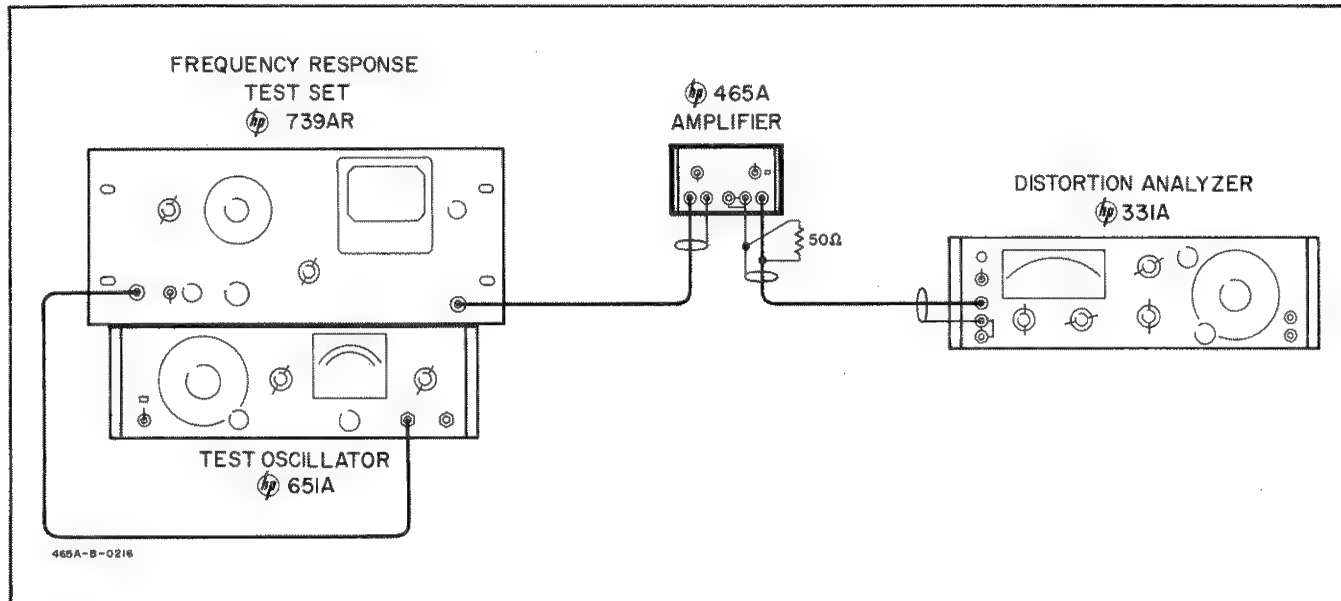


Figure 5-2. Distortion Check

- c. Set Model 465A GAIN to 20 DB.
- d. Set distortion analyzer to METER.
- e. Set oscillator frequency to 1 kc; adjust oscillator output to provide distortion analyzer (voltmeter) reading of 5 v.
- f. Adjust frequency response test set METER SET control to desired SET LEVEL.
- g. Switch distortion analyzer FUNCTION to SET LEVEL; METER RANGE to SET LEVEL and SENSITIVITY for upscale meter deflection. Adjust VERNIER for full scale reading of 1 (100%).
- h. Rotate FUNCTION switch to DISTORTION. Null out fundamental of signal by alternately reducing METER RANGE and adjusting BALANCE and frequency control knob for null.
- j. Final null will indicate amount of distortion (%) present in Model 465A output signal. At 1 kc, distortion should be less than 1%.
- k. Repeat the above test for oscillator frequencies listed in Table 5-3. Entire test should be repeated with Model 465A GAIN set to 40 db. Refer to Table 5-3 for oscillator frequencies and distortion tolerances. Monitor frequency response test set SET LEVEL to insure constant oscillator output amplitude.

Table 5-3. Distortion Check

-hp- Model 465A Gain (db)	Oscillator -hp- Model 651A		Distortion Analyzer -hp- Model 331A	
	Frequency	Output	Frequency	Maximum Disposition
20	1 kc	1.0 v	1 kc	1%
20	50 kc	1.0 v	50 kc	1%
20	500 kc	1.0 v	500 kc	2%
20	10 cps	1.0 v	10 cps	1%
40	1 kc	0.1 v	1 kc	1%
40	50 kc	0.1 v	50 kc	1%
40	500 kc	0.1 v	500 kc	2%
40	10 cps	0.1 v	10 cps	1%

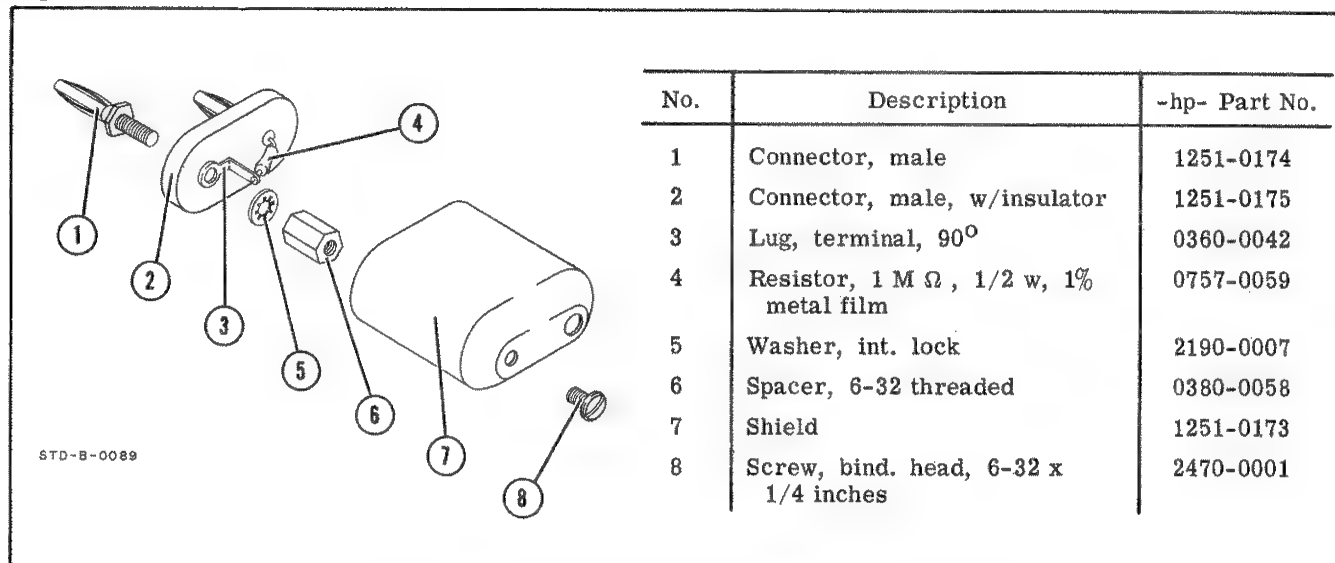


Figure 5-3. Shielded Load for Residual Noise Check

#### 5-12. NOISE CHECK.

- An AC Voltmeter (-hp- Model 331A) and a 1 megohm shielded resistor (refer to Figure 5-3) will be required for this test.
- Connect ac voltmeter to Model 465A OUTPUT; RANGE to .003 V.
- Set Model 465A GAIN to 40 db.
- Connect 1 megohm shielded resistor across Model 465A INPUT.
- AC voltmeter must read less than 2.5 mv (or 25 microvolts referred to input).

#### 5-13. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-14. The following is a complete Adjustment and Calibration Procedure for the -hp- Model 465A Amplifier. These operations should be conducted only if it has previously been established by the Performance Checks, Paragraph 5-5, that the Model 465A is out of adjustment. Indiscriminate adjustment of the internal controls to "refine" readings may actually cause more difficulty. If the procedures outlined below do not rectify any discrepancies which may exist, and all connections and settings have been rechecked, refer to Paragraph 5-21, Troubleshooting Techniques, for possible cause and recommended corrective action.

#### 5-15. POWER SUPPLY ADJUST (+45 V).

- A DC Voltmeter (-hp- Model 3440A/3445A) will be required for this test.
- Set voltmeter FUNCTION to DC; RANGE to 100.

c. Connect positive lead to + side of C20; common lead to common. DC voltmeter should read +45 v ( $\pm 1$  v).

d. If not, adjust R32 for proper reading.

#### 5-16. BIAS ADJUST (R15).

a. A DC Voltmeter (-hp- Model 3440A/3445A) will be required for this test.

b. Set dc voltmeter FUNCTION to DC; RANGE to 100 V.

c. Connect positive lead to + side of C15; common lead to common. DC voltmeter should read +23 v ( $\pm 0.5$  v).

d. If not, adjust R15 to obtain proper reading.

#### 5-17. 1 MC ADJUST (C5).

a. A Test Oscillator (-hp- Model 651A) and an AC Voltmeter (-hp- Model 331A) will be required for this test.

b. Set Model 465A GAIN to 20 db.

c. Connect oscillator OUTPUT to Model 465A INPUT. Set oscillator frequency to 1 Mc; adjust output to 1.0 v rms (use ac voltmeter to verify).

d. Connect ac voltmeter to Model 465A OUTPUT.

e. Adjust C5 for ac voltmeter reading of 8.5 v.

#### 5-18. SERVICING ETCHED CIRCUIT BOARD.

5-19. The -hp- Model 465A has one etched circuit board. Use caution when removing it to avoid damaging mounted components. The -hp- part

number for the assembly is silk screened on the exterior of the circuit board to identify it. Refer to Section VI for parts replacement and -hp- part number information.

5-20. The etched circuit board is a plated-through type. The electrical connection between sides of the board is made by a layer of metal plated through the component holes. When working on these boards, observe the following general rules.

- a. Use a low-heat (25 to 30 watts) small-tip soldering iron, and a small diameter rosin core solder.
- b. Circuit components can be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on lead. If a component is obviously damaged, clip leads as close to components as possible and then remove. Excessive heat can cause the circuit and board to separate, or cause damage to the component.
- c. Component lead hole should be cleaned with a toothpick or other appropriate device before inserting new lead.
- d. To replace components, shape new leads and insert them in holes. Reheat with iron, and add solder as required to insure a good electrical connection.
- e. Clean excess flux from the connection and adjoining area.

#### 5-21. TROUBLESHOOTING TECHNIQUE.

5-22. This section contains procedures designed to assist in the isolation of malfunctions. These procedures are based on a systematic analysis of the instrument circuitry. These operations should be

undertaken only after it has been established that the difficulty can not be eliminated by the Adjustment and Calibration Procedures, Paragraph 5-13. An investigation should also be made to insure that the trouble is not a result of conditions external to the Model 465A.

5-23. Conduct a visual check of the Model 465A for possible burned or loose components, loose connections, or any other obvious conditions which might suggest a source of trouble.

5-24. Table 5-4 contains a summary of the front-panel symptoms that may be encountered. It should be used in initial efforts to select a starting point for troubleshooting operations.

5-25. Table 5-5, in conjunction with Figure 5-4, contains procedures which may be used as a guide in isolating malfunctions. The steps in Table 5-5 describe the normal conditions which should be encountered during the checks (circled numbers (N) ) in Figure 5-4.

5-26. The checks outlined in Table 5-5 are not designed to measure all circuit parameters, rather, only to localize the malfunction. Therefore, it is quite possible that additional measurements may be required to completely isolate the problem. Component values may vary slightly between instruments; therefore, it should not be necessary to precisely duplicate voltage values described.

5-27. The conditions discussed in Table 5-5 and Figure 5-4 are based on the following criteria: (1) the + side of C14 is removed from circuit, opening the feedback loop; (2) Model 465A GAIN set to 40 db; and (3) 1 mv, 2 kc signal applied to Model 465A INPUT.

Table 5-4. Front Panel Troubleshooting

Front Panel Symptoms	Possible Cause
Line Lamp not glowing	Check fuse F1, L1, L2, S1, R28, S2 or T1
Functions properly on 20 db position only	Check R3, R4, R5, R6 and Bias Voltages
Functions properly on 40 db position only	Check Bias Voltages and Q1, Q2.

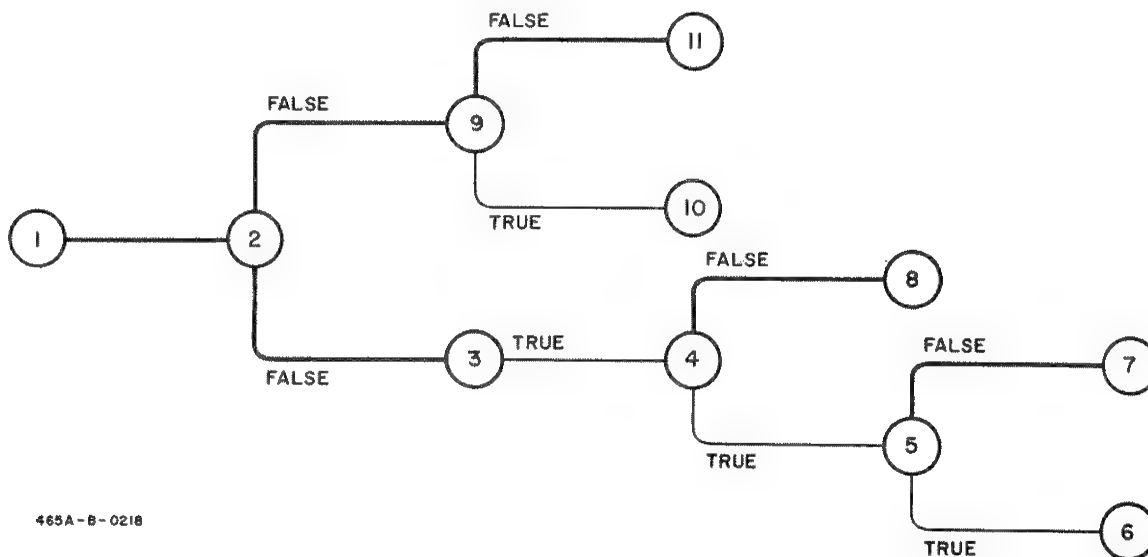


Figure 5-4. Troubleshooting Tree

Table 5-5. Troubleshooting

- |   |   |
|---|---|
| <p>① Remove the + side of C14 from the circuit board. Set Model 465A GAIN to 40 db. Apply a 1.0 mv, 2 kc input signal.</p> <p>② Measure the dc voltage at the + side of C20. Should be +45 v (<math>\pm 1</math> v). If correct, proceed to ③; if incorrect, go directly to ⑨.</p> <p>③ Observe the ac waveform at the Model 465A OUTPUT. Should be a sine wave with peak voltage of approximately 12.7 v (9 v rms). If incorrect, proceed to ④.</p> <p>④ Observe the ac waveform at the base of Q4. Should be a sine wave with peak voltage of approximately 12.7 v (9 v rms). If correct, proceed to ⑤; if incorrect, go directly to ⑧.</p> <p>⑤ Observe the ac waveform at the junction of R24 and R25. Should be a sine wave with peak voltage approximately 12.7 v (9 v rms). If correct, proceed to ⑥; if incorrect, go directly to ⑦.</p> <p>⑥ Check R26, R27 and C15.</p> | <p>⑦ Check Q4, Q5 and Q6. Refer to Figure 5-8 for typical dc voltage levels.</p> <p>⑧ Check Q1, Q2 and Q3. Refer to Figure 5-8 for typical dc voltage levels.</p> <p>⑨ Disconnect jumper wire at the + side of C20, removing power supply from circuit. Measure dc voltage at the + side of C20. Should be +45 v (<math>\pm 1</math> v). If correct, proceed to ⑩; if incorrect, go directly to ⑪.</p> <p>⑩ Connect a DC Power Supply (-hp- Model 723A) to the collectors of Q5 and Q6. Connect the high side to the collector of Q5; the low side to the collector of Q6. Adjust the power supply output to +45 v; set current limit to 75 ma. If power supply indicates current limit, check Q4, Q5, Q6 and CR2-3 for short.</p> <p>⑪ Check Model 465A power supply to include T1 secondary, Q7, CR6, Q8 and Q9. Refer to Figure 5-8 for typical dc voltage levels.</p> |
|---|---|

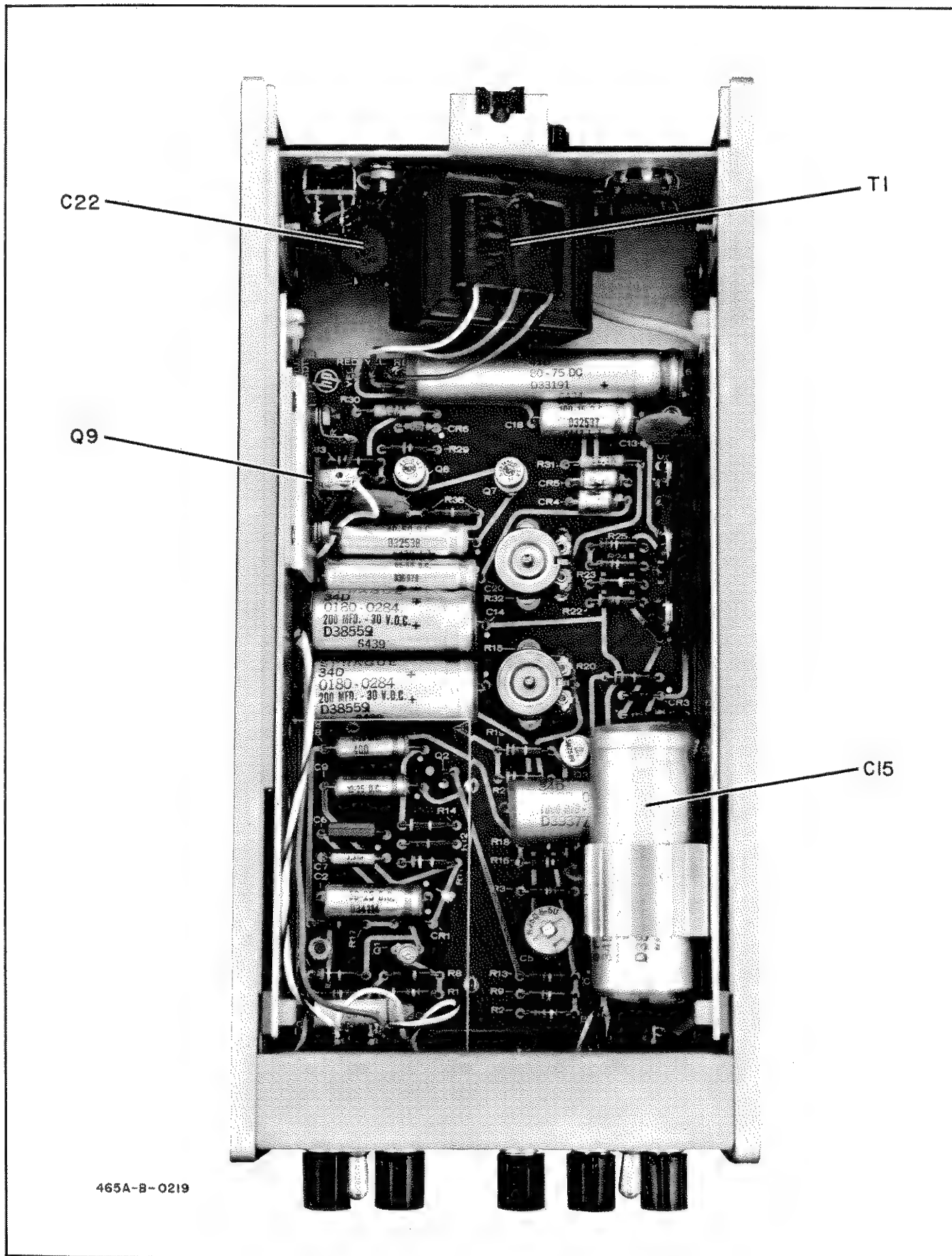
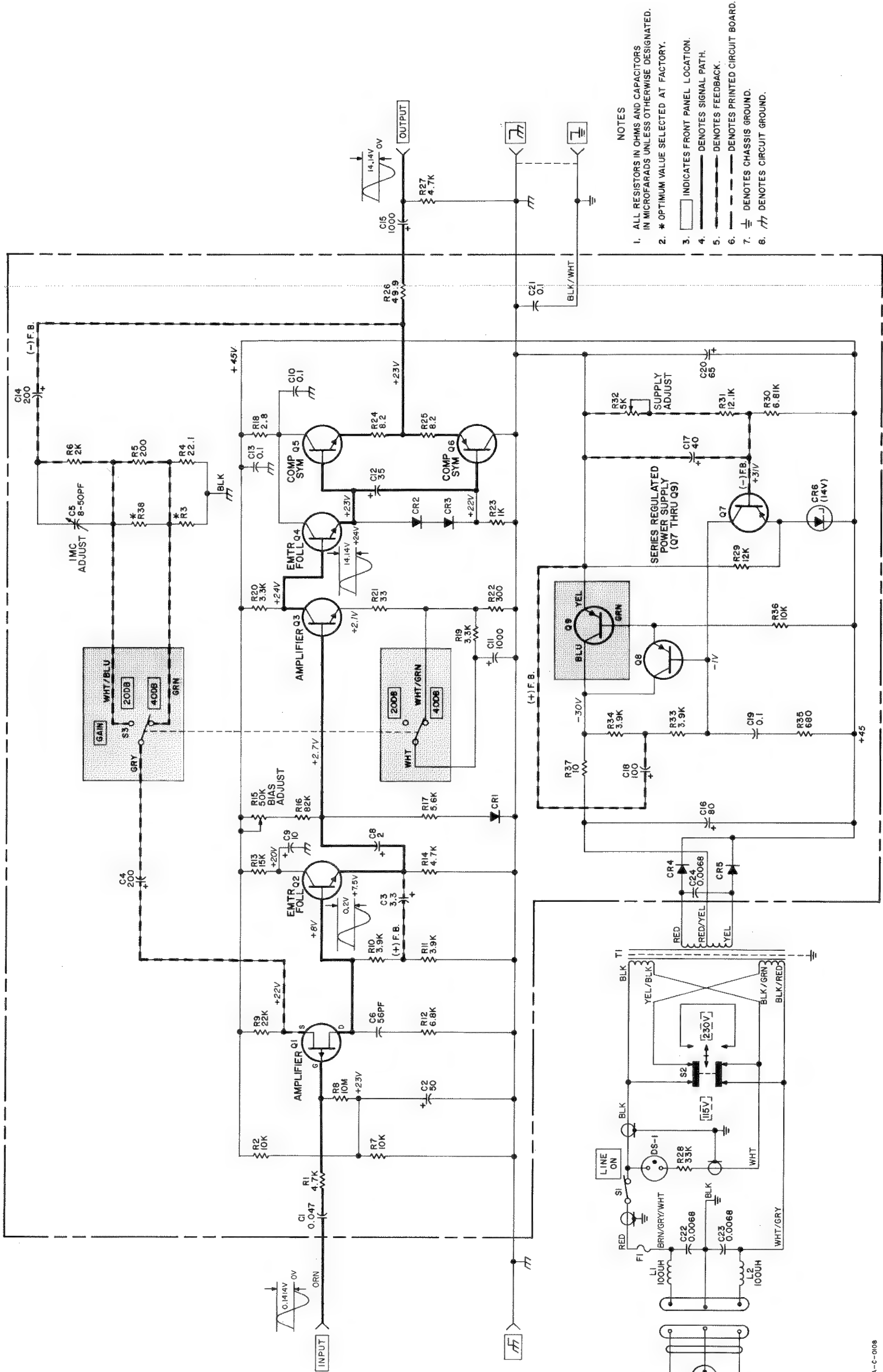


Figure 5-5. Top View



**Figure 5-6. Printed Circuit Board, Parts Location**





465A-C-008

Figure 5-7. Amplifier Schematic

## SECTION VI

### REPLACEABLE PARTS

#### 6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and -hp- part number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their -hp- part number and provides the following information on each part:

- a. Description of the part (see list of abbreviations below).
- b. Typical manufacturer of the part in a five-digit code (see list of manufacturers in Appendix).
- c. Manufacturer's part number.
- d. Total quantity used in the instrument (TQ column).

6-3. Miscellaneous parts are listed at the end of Table 6-1.

#### 6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard part numbers.

#### 6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of the part.
- d. Function and location of the part.

#### REFERENCE DESIGNATORS

A = assembly	F = fuse	P = plug	V = vacuum tube, neon bulb, photocell, etc.
B = motor	FL = filter	Q = transistor	W = cable
C = capacitor	J = jack	R = resistor	X = socket
CR = diode	K = relay	RT = thermistor	XF = fuseholder
DL = delay line	L = inductor	S = switch	XDS = lampholder
DS = device signaling (lamp)	M = meter	T = transformer	Z = network
E = misc electronic part	MP = mechanical part		

#### ABBREVIATIONS

a = amperes	elect = electrolytic	mtg = mounting	rot = rotary
bp = bandpass	encap = encapsulated	my = mylar	rms = root-mean-square
bwo = backward wave oscillator	f = farads	NC = normally closed	rmo = rack mount only
c = carbon	fxd = fixed	Ne = neon	s-b = slow-blow
cer = ceramic	Ge = germanium	NO = normally open	Se = selenium
cmo = cabinet mount only	grd = ground (ed)	NPO = negative positive zero (zero temperature coefficient)	sect = section(s)
coef = coefficient	h = henries	nsr = not separately replaceable	Si = silicon
com = common	Hg = mercury		sil = silver
comp = composition	imp = impregnated		sl = slide
conn = connection	incd = incandescent	obd = order by description	td = time delay
crt = cathode-ray tube	ins = insulation (ed)		TiO <sub>2</sub> = titanium dioxide
dep = deposited	K = kilo = 1000	p = peak	tog = toggle
EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by stock numbers.	lin = linear taper	pc = printed circuit board	tol = tolerance
	log = logarithmic taper	pf = picofarads = 10 <sup>-12</sup> farads	trim = trimmer
	m = milli = 10 <sup>-3</sup>	pp = peak to peak	tw = traveling wave tube
	M = megohms	piv = peak inverse voltage	var = variable
	ma = milliamperes	pos = position (s)	w/ = with
	μ = micro = 10 <sup>-6</sup>	pot = potentiometer	W = watts
	minat = miniature		ww = wirewound
	mfgl = metal film on glass		w/o = without
	mfr = manufacturer	rect = rectifier	* = optimum value selected at factory, average value shown (part may be omitted)

Table 6 -1. Reference Designation Index

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A1	00465-66501	Board Etched Circuit Ass'y Power Supply-Amplifier, includes: C1 thru C24 Q1 thru Q8 CR1 thru CR6 R1 thru R37	
A1C1	0170-0060	C: fxd, my die, .047 mf $\pm 10\%$ , 400 vdcw	
A1C2	0180-0105	C: fxd, alum elect, 50 $\mu$ f -10% +100%, 25 vdcw	
A1C3	0180-0161	C: fxd, tanta elect $\pm 20\%$	
A1C4	0180-0284	C: fxd, alum elect -10% +75%	
A1C5	0130-0017	C: var, ceramic, 8-50 pf	
A1C6	0140-0014	C: fxd, molded mica, 56 pf $\pm 10\%$	
A1C7		Not Assigned	
A1C8	0180-0111	C: fxd, alum elect, 2 $\mu$ f, 25 vdcw	
A1C9	0180-0059	C: fxd, elect, 10 $\mu$ f -10% +100%, 25 vdcw	
A1C10	0150-0084	C: fxd, ceramic die, .1 $\mu$ f +80% -20%, 50 vdcw	
A1C11	0180-0305	C: fxd, alum elect -10% +100%	
A1C12	0180-0064	C: fxd, elect, 35 $\mu$ f -10% +100%, 6 vdcw	
A1C13	0150-0084	C: fxd, ceramic die, .1 $\mu$ f +80% -20%, 50 vdcw	
A1C14	0180-0284	C: fxd, alum elect -10% +75%	
A1C15		Not Assigned	
A1C16	0180-0110	C: fxd, alum elect, 80 $\mu$ f, 75 vdcw	
A1C17	0180-0050	C: fxd, alum elect, 40 $\mu$ f -15% +100%, 50 vdcw	
A1C18	0180-0061	C: fxd, elect, 100 $\mu$ f +100% -10%, 150 vdcw	
A1C19	0150-0084	C: fxd, ceramic die, .1 $\mu$ f +80% -20%, 50 vdcw	
A1C20	0180-0149	C: fxd, alum elect -10% +100%	
A1C21	0170-0022	C: fxd, my die, 0.1 $\mu$ f $\pm 20\%$ , 600 vdcw	
A1C22 and A1C23		Not Assigned	
A1C24	0150-0097	C: fxd, ceramic, .0068 $\mu$ f $\pm 2\%$ , 1000 vdcw	
A1CR1 thru A1CR3	1901-0025	Diode: Si	
A1CR4 and A1CR5	1901-0026	Diode: Si, 200 PIV	
A1CR6	1902-0040	Diode: breakdown, 400 mw	
A1Q1	1855-0004	Transistor: P channel	
A1Q2	1854-0033	Transistor: Si, NPN, 2N3391	
A1Q3	1854-0070	Transistor: Si, NPN	
A1Q4 and A1Q5	1854-0039	Transistor: Si, NPN, 2N3053	
A1Q6	1853-0017	Transistor: Si, PNP	
A1Q7 and A1Q8	1850-0128	Transistor: germanium, PNP, 2N398B	
A1R1	0687-4721	R: fxd, comp, 4700 ohms $\pm 10\%$ , 1/2 w	
A1R2	0687-1031	R: fxd, comp, 10 K ohms $\pm 10\%$ , 1/2 w	
A1R3		Not Assigned	
A1R4	0757-0992	R: fxd, met flm, 22.1 ohms $\pm 1\%$ , 1/2 w	
A1R5	0698-3186	R: fxd, 200 ohms $\pm 1/2 \%$	
A1R6	0698-3187	R: fxd, 2 K ohms $\pm 1/2 \%$	

# See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A1R7	0687-1031	R: fxd, comp, 10 K ohms $\pm 10\%$ , 1/2 w	
A1R8	0687-1061	R: fxd, comp, 10 M ohms $\pm 10\%$ , 1/2 w	
A1R9	0687-2231	R: fxd, comp, 22 K ohms $\pm 10\%$ , 1/2 w	
A1R10 and A1R11	0687-3921	R: fxd, comp, 3300 ohms $\pm 10\%$ , 1/2 w	
A1R12	0687-6821	R: fxd, comp, 6800 ohms $\pm 10\%$ , 1/2 w	
A1R13	0687-1531	R: fxd, comp, 15 K ohms $\pm 10\%$ , 1/2 w	
A1R14	0687-4721	R: fxd, comp, 4700 ohms $\pm 10\%$ , 1/2 w	
A1R15	2100-0094	R: var, comp, lin taper, 50 K ohms $\pm 30\%$ , 0.10 w	
A1R16	0686-8235	R: fxd, comp, 82 K ohms $\pm 5\%$ , 1/2 w	
A1R17	0687-5621	R: fxd, comp, 5600 ohms $\pm 10\%$ , 1/2 w	
A1R18	0698-0001	R: fxd, comp, 4.7 ohms $\pm 5\%$ , 1/2 w	
A1R19 and A1R20	0687-3321	R: fxd, comp, 3300 ohms $\pm 10\%$ , 1/2 w	
A1R21	0686-3305	R: fxd, comp, 33 ohms $\pm 5\%$ , 1/2 w	
A1R22	0686-3015	R: fxd, comp, 300 ohms $\pm 5\%$ , 1/2 w	
A1R23	0687-1021	R: fxd, comp, 1000 ohms $\pm 10\%$ , 1/2 w	
A1R24 and A1R25	0690-0003	R: fxd, comp, 8.2 ohms $\pm 10\%$ , 1/2 w	
A1R26	0757-0072	R: fxd, 49.9 ohms $\pm 1\%$	
A1R27 and A1R28		Not Assigned	
A1R29	0687-1231	R: fxd, comp, 12 K ohms $\pm 10\%$ , 1/2 w	
A1R30	0757-0835	R: fxd, 6.81 K ohms $\pm 1\%$	
A1R31	0757-0841	R: fxd, 12.1 K ohms $\pm 1\%$	
A1R32	2100-0091	R: var, comp, lin taper, 5 K ohms $\pm 30\%$ , 0.15 w	
A1R33 and A1R34	0687-3921	R: fxd, comp, 3300 ohms $\pm 10\%$ , 1/2 w	
A1R35	0687-1511	R: fxd, comp, 150 ohms $\pm 10\%$ , 1/2 w	
A1R36	0687-1531	R: fxd, comp, 15 K ohms $\pm 10\%$ , 1/2 w	
A1R37	0687-1001	R: fxd, comp, 10 ohms $\pm 10\%$ , 1/2 w	
C1 thru C14		Not Assigned	
C15	0180-0378	C: fxd, alum elect $-10\%$ $+100\%$	
C16 thru C21		Not Assigned	
C22 and C23	0150-0097	C: fxd, ceramic, .0068 $\mu$ f $\pm 2\%$ , 1000 vdcw	
DS1	2140-0015	Lamp, glow	
F1	2110-0017	Fuse: cartridge, 0.15 amp	
L1 and L2	9140-0029	Coil - R. F.	
Q1 thru Q8		Not Assigned	
Q9	1850-0098	Transistor: germanium, PNP	
R1 thru R26		Not Assigned	
R27	0687-4721	R: fxd, comp, 4700 ohms $\pm 10\%$ , 1/2 w	
R28	0684-3331	R: fxd, comp, 33 K ohms $\pm 10\%$ , 1/4 w	

# See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
S1	3101-0037	Switch: toggle, SPST, 3 amp	
S2	3101-0033	Switch: slide, DPDT	
S3	3101-0038	Switch: toggle, DPDT, 3 amp	
T1	9100-0343	Transformer: power	
W1	8120-0078	Cable Ass'y, Power: black, extra limp, 7.5 ft. long	
		<u>MISCELLANEOUS</u>	
	0340-0099	Insulator: grey, plastic	
	0340-0100	Insulator: grey, plastic	
	1200-0043	Insulator	
	1200-0081	Insulator	
	1205-0050	Heat + sink	
	>1250-0252	Connector: R. F.	
	1251-1009	Connector: power	
	1400-0084	Holder - fuse	
	1490-0031	Stand - tilt	
	1510-0010	Binding Post - red	
	1510-0011	Binding Post - black	
	5000-0700	Cover - side	
	5000-0711	Cover - bottom	
	5020-0700	Spacer - CAB	
	5040-0234	Jewel - pilot light	
	5040-0235	Base - pilot light	
	5040-0700	Hinge	
	5060-0700	Frame Ass'y	
	5060-0709	Cover - top	
	5060-0727	Foot - Ass'y	
	5060-4916	Terminal - ground, black	
	00465-00101	Plate - right	
	00465-00102	Plate - left	
	00465-00201	Panel - front	
	00465-00202	Panel - rear	
	00465-01201	Bracket - transistor	
	00465-90000	Manual - Operating and Service	

> Option 01 only  
# See introduction to this section

Table 6-2. Replaceable Parts

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ
0130-0017	C: var, ceramic, 8-50 pf	72982	557-019-U2PO-34 R	1
0140-0014	C: fxd, molded mica, 56 pf $\pm 10\%$	04062	RCM15E 560K	1
0150-0084	C: fxd, ceramic, die, .1 $\mu$ f $+80\%$ -20%, 50 vdcw	56289	33C41	3
0150-0097	C: fxd, ceramic, .0068 $\mu$ f $\pm 2\%$ , 1000 vdcw	91418	B	2
0170-0022	C: fxd, my die, 0.1 $\mu$ f $\pm 20\%$ , 600 vdcw	01281	HEW-17	1
0170-0060	C: fxd, my die, .047 mf $\pm 10\%$ , 400 vdcw	01281	Type 663UW	1
0180-0050	C: fxd, alum elect, 40 $\mu$ f -15% +100%, 50 vdcw	56289	D32538	1
0180-0059	C: fxd, elect, 10 $\mu$ f -10% +100%, 25 vdcw	56289	30D106G025BB4	1
0180-0061	C: fxd, elect, 100 $\mu$ f +100% -10%, 15 vdcw	56289	30D107G015DD4	1
0180-0064	C: fxd, elect, 35 $\mu$ f -10% +100%, 6 vdcw	56289	30D156G006BB4	1
0180-0105	C: fxd, alum elect, 50 $\mu$ f -10%, +100%, 25 vdcw	56289	D34114	1
0180-0110	C: fxd, alum elect, 80 $\mu$ f, 75 vdcw	56289	41D D33191	1
0180-0111	C: fxd, alum elect, 2 $\mu$ f, 25 vdcw	56289	40D 173A2	1
0180-0149	C: fxd, alum elect, -10% +100%	56289	Type 30D	1
0180-0161	C: fxd, tanta elect, $\pm 20\%$	56289	150D335 X 0035 B2	1
0180-0284	C: fxd, alum elect -10% +75%	56289	D38559	2
0180-0305	C: fxd, alum elect -10% +100%	56289	34D108H2R5FJ4	1
0180-0378	C: fxd, alum elect, -10% +100%	56289	34D108H030JP4	1
0340-0099	Insulator: grey, plastic	28480	0340-0099	1
0340-0100	Insulator: grey, plastic	28480	0340-0100	1
0684-3331	R: fxd, comp, 33 K ohms $\pm 10\%$ , 1/4 w	01121	CB 3331	1
0686-3015	R: fxd, comp, 300 ohms $\pm 5\%$ , 1/2 w	01121	EB 3015	1
0686-3305	R: fxd, comp, 33 ohms $\pm 5\%$ , 1/2 w	01121	EB 3305	1
0686-8235	R: fxd, comp, 82 K ohms $\pm 5\%$ , 1/2 w	01121	EB 8235	1
0687-1001	R: fxd, comp, 10 ohms $\pm 10\%$ , 1/2 w	01121	EB 1001	1
0687-1021	R: fxd, comp, 1000 ohms $\pm 10\%$ , 1/2 w	01121	EB 1021	1
0687-1031	R: fxd, comp, 10 K ohms $\pm 10\%$ , 1/2 w	01121	EB 1031	2
0687-1061	R: fxd, comp, 10 M ohms $\pm 10\%$ , 1/2 w	01121	EB 1061	1
0687-1231	R: fxd, comp, 12 K ohms $\pm 10\%$ , 1/2 w	01121	EB 1231	1
0687-1511	R: fxd, comp, 150 ohms $\pm 10\%$ , 1/2 w	01121	EB 1511	1
0687-1531	R: fxd, comp, 15 K ohms $\pm 10\%$ , 1/2 w	01121	EB 1531	2
0687-2231	R: fxd, comp, 22 K ohms $\pm 10\%$ , 1/2 w	01121	EB 2231	1
0687-3321	R: fxd, comp, 3300 ohms $\pm 10\%$ , 1/2 w	01121	EB 3321	1
0687-3921	R: fxd, comp, 3.9 K ohms $\pm 10\%$ , 1/2 w	01121	EB 3921	2
0687-4721	R: fxd, comp, 4700 ohms $\pm 10\%$ , 1/2 w	01121	EB 4721	3
0687-5621	R: fxd, comp, 5600 ohms $\pm 10\%$ , 1/2 w	01121	EB 5621	1
0687-6821	R: fxd, comp, 6800 ohms $\pm 10\%$ , 1/2 w	01121	EB 6821	1
0698-0001	R: fxd, comp, 4.7 ohms $\pm 5\%$ , 1/2 w	01121	EB 47G5	1
0698-3186	R: fxd, 200 ohms $\pm 1/2\%$	19701	CEC T-O	1
0698-3187	R: fxd, 2 K $\pm 1/2\%$	19701	MF7C T-O	1
0699-0003	R: fxd, comp, 8.2 ohms $\pm 10\%$ , 1/2 w	01121	EB 82G1	1
0757-0072	R: fxd, 49.9 ohms $\pm 1\%$	19701	MF7C T-O	1
0757-0835	R: fxd, 6.81 K ohms $\pm 1\%$	19701	MF7C T-O	1
0757-0841	R: fxd, 12.1 K ohms $\pm 1\%$	19701	MF7C T-O	1
0757-0992	R: fxd, met flm, 22.1 ohms $\pm 1\%$ , 1/2 w	19701	MF7C T-O	1

# See introduction to this section



Table 6-2. Replaceable Parts (Cont'd)

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
1200-0043	Insulator	71785	293011	1	
1200-0081	Insulator: bushing, nylon	26365	974	1	
1205-0050	Heat - sink	91506	9017-1G1	1	
>1250-0252	Connector: R. F.	06140	30288-1	2	
1251-1009	Connector: ac power cord receptacle	82389	AC-3	1	
1400-0084	Holder - fuse	75915	342014	1	
1490-0031	Stand - tilt	91260	obd #	1	
1510-0010	Binding Post - red	28480	1510-0010	2	
1510-0011	Binding Post - black	28480	1510-0011	2	
1850-0098	Transistor: germanium, PNP	77068	B-1493	1	
1850-0128	Transistor: germanium, PNP, 2N398B	86684	2N398B	1	
1853-0017	Transistor: Si, PNP	04713	obd #	1	
1854-0033	Transistor: Si, NPN, 2N3391	24446	2N3391	1	
1854-0039	Transistor: Si, NPN, 2N3053	86684	2N3053	1	
1854-0070	Transistor: Si, NPN	24446	obd #	1	
1855-0004	Transistor: P channel	17856	U112	1	
1901-0025	Diode: Si	93332	D3072	1	
1901-0026	Diode: Si, 200 PIV	11711	obd #	1	
1902-0040	Diode: breakdown, 400 mw	04713	SZ10939-224	1	
2100-0091	R: var, comp, lin taper, 5 K ohms $\pm 30\%$ , 0.15 w	71450	UPE 70RE	1	
2100-0094	R: var, comp, lin taper, 50 K ohms $\pm 30\%$ , 0.10 w	71450	UPE 70RE	1	
2110-0017	Fuse - cartridge, 0.15 amp	98997	3AG-TL-15/100	1	
2140-0015	Lamp, glow	24455	obd #	1	
3101-0033	Switch - slide, DPDT	79727	G-326	1	
3101-0037	Switch - toggle, SPST, 3 amp	04009	83050-A	1	
3101-0038	Switch - toggle, DPDT, 3 amp	04009	83054-B	1	
5000-0700	Cover - side	28480	5000-0700	1	
5000-0711	Cover - bottom	28480	5000-0711	1	
5020-0700	Spacer - CAB	28480	5020-0700	1	
5040-0234	Jewel - pilot light	28480	5040-0234	1	
5040-0235	Base - pilot light	28480	5040-0235	1	
5040-0700	Hinge	28480	5040-0700	1	
5060-0700	Frame Ass'y	28480	5060-0700	1	
5060-0709	Cover - top	28480	5060-0709	1	
5060-0727	Foot Ass'y	28480	5060-0727	1	
5060-4916	Terminal - ground, black	28480	5060-4916	1	
8120-0078	Cable Ass'y, power: black, extra limp, 7.5 ft. long	70903	KH-4147	1	
9100-0343	Transformer, power	28480	9100-0343	1	
9140-0029	Coil - R. F.	99848	3100-15-101	2	
00465-00101	Plate - right	28480	00465-00101	1	
00465-00102	Plate - left	28480	00465-00102	1	
00465-00201	Panel - front	28480	00465-00201	1	
00465-00202	Panel - rear	28480	00465-00202	1	
00465-01201	Bracket - transistor	28480	00465-01201	1	
00465-66501	Board Etched Circuit Ass'y Power Supply - Amplifier	28480	00465-66501	1	
00465-90000	Manual, Operating and Service	28480	00465-90000	1	

&gt; Option 01 only

# See introduction to this section

# **APPENDIX** **CODE LIST OF MANUFACTURERS (Sheet 1 of 2)**

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U.S.	07115	Corning Glass Works	Bradford, Pa.	24655	General Radio Co.	West Concord, Mass.	73293	Hughes Products Division of	Newport Beach, Calif.
00136	McCoy Electronics	Mount Holly Springs, Pa.		Electronic Components Dept.	Bradford, Pa.	26365	Gries Reproductor Corp.	New Rochelle, N.Y.		Amperex Electronic Co., Div. of North	
00213	Sage Electronics Corp.	Rochester, N. Y.	07126	Digitran Co.	Pasadena, Calif.	26462	Grobel File Co. of America, Inc.	Calistado, N.J.	73445	American Phillips Co., Inc.	Hicksville, N.Y.
00334	Humidail Co.	Colton, Calif.	07137	Transistor Electronics Corp.	Minneapolis, Minn.	26992	Hamilton Watch Co.	Lancaster, Pa.	73490	Beckman Hellipot Corp.	So. Pasadena, Calif.
00335	Westrex Corp.	New York, N. Y.	07138	Westinghouse Electric Corp.	Electronic Tube Div.	28480	Hewlett-Packard Co.	Palo Alto, Calif.	73506	Bradley Semiconductor Corp.	Hamden, Conn.
00373	Garlock Packing Co.,		07149	Filmohm Corp.	New York, N. Y.	31173	G. E. Receiving Tube Dept.	Owensboro, Ky.	73559	Carling Electric, Inc.	Hartford, Conn.
	Electronic Products Div.	Camden, N. J.	07233	Cinch-Graphik Co.	City of Industry, Calif.	35434	Lectrohm Inc.	Chicago, Ill.	73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
00656	Aerovox Corp.	New Bedford, Mass.	07261	Aveset Corp.	Los Angeles, Calif.	36196	Stanwyck Corp.	Hawkesbury, Ontario, Canada	73734	Federal Screw Prod. Co.	Chicago, Ill.
00779	Amp, Inc.	Harrisburg, Pa.	07263	Fairchild Semiconductor Corp.		37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
00781	Aircraft Radio Corp.	Boonton, N. J.				39543	Mechanical Industries Prod. Co.	Akron, Ohio	73793	The General Industries Co.	Elyria, Ohio
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	40820	Miniature Precision Bearings, Inc.	Chicago, Ill.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.
			07387	The Birchler Corp.	Chicago, Ill.	42190	Muter Co.	Chicago, Ill.	73899	JFD Electronics Corp.	Brooklyn, N. Y.
00853	Sagano Electric Company,		07700	Technical Wire Products	Springfield, N. J.	44655	Ohmite Mfg. Co.	Skokie, Ill.	73905	Jennings Radio Mfg. Co.	Neptune, N.J.
	Ordill Division (Capacitors)	Marion, Ill.	07910	Continental Device Corp.	Hawthorne, Calif.	47904	Polaroid Corp.	Cambridge, Mass.	74276	Signalite Inc.	Winchester, Mass.
00866	Goe Engineering Co.	Los Angeles, Calif.	07933	Rheem Semiconductor Corp.	Mountain View, Calif.	48620	Precision Thermometer and		74455	J. H. Wines and Sons	Chicago, Ill.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.				74861	Industrial Condenser Corp.	Danbury, Conn.
01121	Allen Bradley Co.	Milwaukee, Wis.	07980	Boonton Radio Corp.	Boonton, N. J.	49566	Raytheon Company	Lexington, Mass.	74868	R. F. Products Division of Ampheno-	
01255	Liton Industries, Inc.	Beverly Hills, Calif.	08145	U.S. Engineering Co.	Los Angeles, Calif.	52050	Ronan Controller Co.	Baltimore, Md.		Borg Electronics Corp.	Wesaca, Minn.
01281	TRW Semiconductors Inc.	Lawndale, Calif.	08289	Blinn, Delbert, Co.	Pomona, Calif.	63743	Ward Leonard Electric	St. Vernon, N.Y.	74970	E. F. Johnson Co.	Philadelphia, Pa.
01295	Texas Instruments, Inc.		08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.	54294	Shaltcross Mfg. Co.	Chicago, Ill.	75042	International Resistance Co.	Chicago, Ill.
	Transistor Products Div.	Dallas, Texas				55026	Simpson Electric Co.	Chicago, Ill.	75173	Jones, Howard B., Division	
01349	The Alliance Mfg. Co.	Alliance, Ohio	08717	Stoan Company	Burbank, Calif.	55933	Sonolone Corp.	Elmsford, N.Y.		of Cinch Mfg. Corp.	Chicago, Ill.
01561	Chassi-Trak Corp.	Indianapolis, Ind.	08718	Cannon Electric Co., Phoenix Div.	Phoenix, Ariz.	55938	Sorenson & Co., Inc.	So. Norwalk, Conn.	75378	James Knights Co.	Sandwich, Ill.
01589	Pacific Relays, Inc.	Van Nuys, Calif.	08792	CBS Electronics Semiconductor Operations, Div. of C.B.S., Inc.	Lowell, Mass.	56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.	75382	Kulka Electric Corporation	Brooklyn, N.Y.
01930	Amerock Corp.	Rockford, Ill.	08924	Mei-Rain	Indianapolis, Ind.	56289	Sprague Electric Co.	North Adams, Mass.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.	09098	Babcock Relays, Inc.	Costa Mesa, Calif.	58446	Telex, Inc.	St. Paul, Minn.	75915	Littlefuse Inc.	Des Plaines, Ill.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.	09134	Texas Capacitor Co.	Houston, Texas	59730	Thomas & Betts Co.	Elizabeth, N. J.	76005	Lord Mfg. Co.	Erie, Pa.
02286	Cole Mfg. Co.	Palo Alto, Calif.	09145	Alchem Electronics	San Valley, Calif.	60741	Tripplett Electrical Inc.	Bluffton, Ohio	76210	C. W. Marwedel	San Francisco, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.	09250	Electro Assemblies, Inc.	Chicago, Ill.	61775	Union Switch and Signal, Div. of	Westinghouse Air Brake Co.	76403	Micamold Electronic Mfg. Corp.	San Francisco, N.Y.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.	09569	Mallory Battery Co. of	Canada, Ltd.				76487	James Millett Mfg. Co., Inc.	Malden, Mass.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	09664	The Bristol Co.	Toronto, Ontario, Canada	62119	Universal Electric Co.	Swissvale, Pa.	76493	J. W. Miller Co.	Los Angeles, Calif.
			10214	General Transistor Western Corp.	Los Angeles, Calif.	63743	West-Leonard Electric Co.	Owosso, Mich.	76530	Monodnock Mills	San Leandro, Calif.
02777	Hopkins Engineering Co.	San Fernando, Conn.				64599	Western Electric Co., Inc.	St. Vernon, N.Y.	76545	Muelter Electric Co.	Cleveland, Ohio
03508	G. E. Semiconductor Products Dept.	Syracuse, N. Y.				65092	Weston Inst. Div. of Daystrom, Inc.	New York, N.Y.	76584	Oak Manufacturing Co.	Crystal Lake, Ill.
03705	Apex Machine & Tool Co.	Drayton, Ohio				66295	Wittek Manufacturing Co.	Chicago 23, Ill.	77068	Bendix Pacific Division of	
03797	Eldenco Corp.	El Monte, Calif.	10411	Ti-Tal, Inc.	Berkeley, Calif.	66346	Wollensak Optical Co.	Rochester, N. Y.		Bendix Corp.	No. Hollywood, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.	10646	Carborundum Co.	Niagara Falls, N.Y.	70276	Allen Mfg. Co.	Hartford, Conn.	77075	Pacific Metals Co.	San Francisco, Calif.
03898	Pyrofilm Resistor Co.	Marristown, N. J.	11236	CTS of Berne, Inc.	Berne, Ind.	70309	Allied Control Co., Inc.	New York, N.Y.	77221	Phaotran Instrument and	
03954	P. R. Motor Company	Los Angeles, Calif.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.	70319	Almetal Screw Prod. Co., Inc.	Garden City, N.Y.		Electronic Co.	South Pasadena, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.							77250	Phoel Mfg. Co.	Chicago, Ill.
			11312	Microwave Electronics Corp.	Palo Alto, Calif.	70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
04013	Taurus Corp.	Lambertville, N. J.	11534	Duncan Electronic, Inc.	Santa Ana, Calif.	70563	Amperite Co., Inc.	New York, N.Y.	77342	Potter and Blumfield, Div. of	Philadelphia, Pa.
04062	Elmenco Products Co.	New York, N. Y.	11711	General Instrument Corporation	Newark, N. J.	70903	Belden Mfg. Co.	Chicago, Ill.		Machine and Foundry	Princeton, Ind.
04222	H-I-Q Division of Aerovox	Myrtle Beach, S. C.		Semiconductor Division		70998	Bird Electronic Corp.	Cleveland, Ohio	77630	Radio Condenser Co.	Camden, N. J.
04298	Elgin National Watch Co.		11717	Imperial Electronic, Inc.	Buena Park, Calif.	71002	Birnbach Radio Co.	New York, N.Y.	77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
	Electronics Division	Burbank, Calif.	11870	Melabs, Inc.	Palo Alto, Calif.	71041	Boston Gear Works Div. of	Quincy, Mass.	77784	Resistance Products Co.	Harrisburg, Pa.
04354	Precision Paper Tube Co.	Chicago, Ill.	12136	Philadelphia Handle Co.	Camden, N. J.		Murray Co. of Texas	Cleveland, Ohio	77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.	12697	Claroat Mfg. Co.	Dover, N. H.	71218	Bud Radio Inc.	Paramus, N. J.	78189	Shakeproof Division of Illinois	
			12859	Nippon Electric Co., Ltd.	Tokyo, Japan	71226	Canic Fastener Corp.	Plainville, Conn.		Tool Works	Elgin, Ill.
04651	Sylvania Electric Prods., Inc.	Mountain View, Calif.	12930	Delta Semiconductor Inc.	Newport Beach, Calif.	71313	Allen D. Cardwell Electronic Prod. Corp.	St. Louis, Mo.	78283	Signal Indicator Corp.	New York, N. Y.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	13103	Thermolloy	Dallas, Texas	71400	Bussmann Fuse Div. of McGraw-Edison Co.	Chicago, Ill.	78296	Struthers-Dunn Inc.	Pittman, N. J.
			13396	Telefunken (G.M.B.H.)	Hannover, Germany				78452	Thompson-Bremer & Co.	Chicago, Ill.
04732	Filtcon Co., Inc., Western Div.	Culver City, Calif.	13835	Midland Mfg. Co.	Kansas City, Kansas	71436	Chicago Condenser Corp.	Chicago, Ill.	78471	Tilley Mfg. Co.	San Francisco, Calif.
04733	Automatic Electric Co.	Northlake, Ill.	14099	Sem-Tech	Newbury Park, Calif.	71450	CTS Corp.	Elkhart, Ind.	78488	Stackpole Carbon Co.	St. Marys, Pa.
04777	Automatic Electric Sales Corp.	Northlake, Ill.	14193	Calif. Resistor Corp.	Santa Monica, Calif.	71469	Cannon Electric Co.	Los Angeles, Calif.	78493	Standard Thomson Corp.	Waltham, Mass.
04796	Squid Wire & Cable Co.	Redwood City, Calif.	14298	American Components, Inc.	Conshohocken, Pa.	71471	Cinema Engineering Co.	Burbank, Calif.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
04811	Precision Coil Spring Co.	El Monte, Calif.	14655	Cornell Duplicator Elec. Corp.	So. Plainfield, N. J.	71482	C. P. Clark & Co.	Chicago, Ill.	78790	Transformer Engineers	Pasadena, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.	14960	Williams Mfg. Co.	San Jose, Calif.	71590	Centralab Div. of Globe Union Inc.	Chicago, Ill.	78947	Ucinite Co.	Newtown, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.	15203	Webster Electronics Co. Inc.	Brooklyn, N. Y.				79142	Vendo Root, Inc.	Hartford, Conn.
			15291	Adjustable Bushing Co.	N. Hollywood, Calif.	71616	Commercial Plastics Co.	Chicago, Ill.	79251	Wenco Mfg. Co.	Chicago, Ill.
05277	Westinghouse Electric Corp.,		15772	Twentieth Century		71700	The Cornish Wire Co.	New York, N.Y.	79727	Continental-Witt Electronics Corp.	Philadelphia, Pa.
	Semi-Conductor Dept.	Youngwood, Pa.				71744	Chicago Miniature Lamp Works	Chicago, Ill.			
05347	Ultronic, Inc.	San Mateo, Calif.	15909	The Daven Co.	Livingston, N. J.	71753	A. O. Smith Corp., Crowley Div.	West Orange, N. J.	79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
05593	Humitronic Engineering Co.	Sunnyvale, Calif.	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.				80031	Mesco Division of Sessions	
05616	Cosmo Plastic		16352	Computer Diode Corp.	Lodi, N. J.	71785	Cinch Mfg. Corp.	Chicago, Ill.		Clock Co.	Morristown, N. J.
	(c to Electrical Spec. Co.)	Cleveland, Ohio	16688	De Jur-Amsco Corporation	Long Island City 1, N. Y.	71984	Deo Corning Corp.	Midland, Mich.	80120	Schnitzer Alloy Products	Elizabeth, N. J.
05624	Barber Colman Co.	Rockford, Ill.				72092	Eitel-McCullough, Inc.	San Bruno, Calif.	80130	Times Facsimile Corp.	New York, N.Y.
05728	Tiffen Optical Co.					72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.	80131	Electronic Industries Association, Any brand	Washington, D. C.
			16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.					lube meeting EIA standards	
05729	Metropolitan Telecommunications Corp.,	Brooklyn, N. Y.	17109	Thermometrics Inc.	Canoga Park, Calif.	71707	Coto Coil Co., Inc.	Providence, R.I.	80207	Unimax Switch, Div. of	Watlingford, Conn.
	Metro Cap. Division		17474	Tranex Company	Mountain View, Calif.	72354	John E. Fast & Co.	Chicago, Ill.		W. L. Maxson Corp.	New York, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.	18582	Curtis Instrument Inc.	Des Plaines, Ill.	72619	Dialight Corp.	Brooklyn, N.Y.	80223	United Transformer Corp.	Chicago, Ill.
05820	Wakelief Engineering Inc.	Wakelief, Mass.	18673	E. I. DuPont & Co., Inc.	Wilmington, Del.	72656	General Ceramics Corp.	Keasbey, N. J.	80248	Oxford Electric Corp.	Riverside, Calif.
06004	The Bassick Co.	Bridgeport, Conn.	19315	Eclipse Pioneer, Div. of	Bendix Aviation Corp.				80294	Bourns Laboratories, Inc.	
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	19500	Thomas A. Edison Industries,	West Orange, N. J.	72758	Gizard-Hopkins	Newark, N. J.	80411	Acro Div. of Robertshaw	
06402	E. T. A. Products Co. of America	Chicago, Ill.		Div. of McGraw-Edison Co.		72765	Drake Mfg. Co.	Oakland, Calif.		Fulton Controls Co.	Columbus 16, Ohio
06475	Western Devices, Inc.	Ingleswood, N. Y.	19701	Electra Manufacturing Co.	Kansas City, Mo.	72825	Hugh H. Eby Inc.	Chicago, Ill.	80486	Alt Star Products Inc.	Defiance, Ohio
06540	Anatone Electronic		20183	Electronic Tube Corp.	Philadelphia, Pa.	72928	Gudeman Co.	Philadelphia, Pa.	80509	Avery Adhesive Label Corp.	Monrovia, Calif.
	Hardware Co. Inc.	New Rochelle, N. Y.	21226	Executive, Inc.	New York, N. Y.	72964	Robert M. Hadley Co.	Chicago, Ill.	80583	Hammerlund Co., Inc.	New York, N.Y.
06555	Beebe Electrical Instrument Co., Inc.	Pennacook, N. H.	21520	Fansteele Metallurgical Corp.	No. Chicago, Ill.	72982	Erie Resistor Corp.	Erie, Pa.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
06751	U. S. Sensor Division of Nuclear Corp.	Phoenix, Arizona	21964	Fed. Telephone and Radio Corp.	Clifton, N. J.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	81030	International Instruments, Inc.	New Haven, Conn.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	24446	General Electric Co.	Schenectady, N. Y.	73076	H. M. Harper Co.	Chicago, Ill.	81073	Grayhill Co.	LaGrange, Ill.
07088	Kelvin Electric Co.	Van Nuys, Calif.	24455	G. E., Lamp Division	Nela Park, Cleveland, Ohio	73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.	81095	Triad Transformer Corp.	Venice, Calif.
									81312	Winchester Electronics Co., Inc.	Norwalk, Conn.

Galley 3 - Hewlett Packard Code List

# **APPENDIX** **CODE LIST OF MANUFACTURERS (Sheet 2 of 2)**

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
81349	Military Specification	.....	85474	R. M. Bracamonte & Co.	San Francisco, Calif.	93829	G. V. Controls	Livingston, N. J.	98220	Francis L. Mosley	Pasadena, Calif.
81415	Wilcor Products, Inc.	Cleveland, Ohio	85660	Koiled Kords, Inc.	New Haven, Conn.	93983	Insuline-Van Norman Ind., Inc.	Manchester, N.H.	98278	Microdot, Inc.	So. Pasadena, Calif.
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.	85911	Seamless Rubber Co.	Chicago, Ill.	94137	Electronic Division	Bayonne, N.J.	98291	Sealectro Corp.	Mamaroneck, N.Y.
81483	International Rectifier Corp.	El Segundo, Calif.	86197	Clifton Precision Products	Clifton Heights, Pa.	94144	General Cable Corp.	Quincy, Mass.	98405	Carad Corp.	Redwood City, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.	86579	Precision Rubber Products Corp.	Dayton, Ohio	94145	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.	98731	General Mills	Minneapolis, Minn.
81860	Barry Controls, Inc.	Watertown, Mass.	86684	Radio Corp. of America, RCA	Harrison, N.J.	94148	Scientific Radio Products, Inc.	Newton, Mass.	98821	North Hills Electric Co.	Mineola, N.Y.
82042	Carter Parts Co.	Skokie, Ill.	87216	Phlco Corporation (Lansdale Division)	Lansdale, Pa.	94154	Tung-Sol Electric, Inc.	Loveland, Colo.	98825	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.	87473	Western Fibrous Glass Products Co.	San Francisco, Calif.	94197	Curtiss-Wright Corp., Electronics Div.	Newark, N.J.	98978	International Electronic Research Corp.	Burbank, Calif.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.	87664	Van Waters & Rogers Inc.	Seattle, Wash.	94222	Southco Div. of S. Chester Corp.	East Paterson, N.J.	99109	Columbia Technical Corp.	New York, N.Y.
82209	Maguire Industries, Inc.	Greenwich, Conn.	87930	Tower Mfg. Corp.	Providence, R. I.	94310	The Ohm Prod. Div. of Model Engineering and Mfg. Co.	Lester, Pa.	99313	Varian Associates	Palo Alto, Calif.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.	88140	Cutler-Hammer, Inc.	Lincoln, Ill.	94330	Wire Cloth Products Inc.	Chicago, Ill.	99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
82376	Astron Co.	East Newark, N.J.	88220	Gould-National Batteries, Inc.	St. Paul, Minn.	94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.	99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
82389	Switchcraft, Inc.	Chicago, Ill.	88698	General Mills, Inc.	Buffalo, N.Y.	95023	Philbrick Researchers, Inc.	Boston, Mass.	99800	Delevan Electronics Corp.	East Aurora, N.Y.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.	89231	Graybar Electric Co.	Oakland, Calif.	95236	Allies Products Corp.	Miami, Fla.	99848	Wilco Corporation	Indianapolis, Ind.
82866	Research Products Corp.	Madison, Wis.	89462	Waldee Kohinoor, Inc.	Cambridge, Mass.	95238	Continental Connector Corp.	Woodside, N.Y.	99834	Renbrandt, Inc.	Boston, Mass.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.	89473	General Electric Distributing Corp.	Schenectady, N.Y.	95263	Leecraft Mfg. Co., Inc.	New York, N.Y.	99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
82893	Vector Electronic Co.	Glendale, Calif.	89636	Carter Parts Div. of Economy Saler Co.	Chicago, Ill.	95264	Lorco Electronics, Inc.	Burbank, Calif.	99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.	90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.	95285	National Coil Co.	Sheridan, Wyo.	<p>THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.</p>		
83058	Carr Fastener Co.	Cambridge, Mass.	90970	Bearing Engineering Co.	San Francisco, Calif.	95295	Vibron, Inc.	Bridgeport, Conn.			
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.	91260	Conner Spring Mfg. Co.	San Francisco, Calif.	95348	Gordas Corp.	Bloomfield, N.J.			
83125	Pyramid Electric Co.	Darlington, S.C.	91345	Miller Dial & Nameplate Co.	El Monte, Calif.	95354	Methode Mfg. Co.	Chicago, Ill.			
83148	Electro Cords Co.	Los Angeles, Calif.	91418	Radio Materials Co.	Chicago, Ill.	95712	Dage Electric Co., Inc.	Franklin, Ind.			
83186	Victory Engineering Corp.	Springfield, N.J.	91506	Augat Brothers', Inc.	Attleboro, Mass.	95967	Weckesser Co.	Chicago, Ill.			
83289	Bendix Corp., Red Bank Div.	Red Bank, N.J.	91637	Dale Electronics, Inc.	Columbus, Nebr.	96067	Huggies Laboratories	Sunnyvale, Calif.			
83315	Hobbs Corp.	Mundelein, Ill.	91662	Elco Corp.	Philadelphia, Pa.	96095	Hi-Q Division of Aerovox	Olean, N.Y.			
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.	91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.	96256	Thorndston-Weissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.			
83385	Central Screw Co.	Chicago, Ill.	91827	K F Development Co.	Redwood City, Calif.	96296	Solar Manufacturing Co.	Los Angeles, Calif.			
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.	91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.	96330	Carlton Screw Co.	Chicago, Ill.	0000F	Malco Tool and Die	Los Angeles, Calif.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.	91961	Nahn-Bros. Spring Co.	Oakland, Calif.	96341	Microwave Associates, Inc.	Burlington, Mass.	0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
83740	Eveready Battery	New York, N.Y.	92180	Tru-Connector Corp.	Peabody, Mass.	96501	Excel Transformer Co.	Oakland, Calif.	0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.	92196	Universal Metal Prod., Inc.	Bassett Pointe, Calif.	97464	Industrial Retaining Ring Co.	Irvine, N.J.	0000Z	Willow Leather Products Corp.	Newark, N.J.
83821	Loyd Scruggs Co.	Festus, Mo.	92367	Elget Optical Co., Inc.	Rochester, N.Y.	97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.	0000A	British Radio Electronics Ltd.	Washington, D.C.
84171	Arco Electronics, Inc.	New York, N.Y.	92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.	97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.	0000B	ETA	England
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.	93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.	97979	Reon Resistor Corp.	Yonkers, N.Y.	0000C	Indiana General Corp., Elect. Div.	Indiana
84411	Good All Electric Mfg. Co.	Ogallala, Neb.	93369	Robbins and Myers, Inc.	New York, N.Y.	98141	Axel Brothers Inc.	Jamaica, N.Y.	0000M	Rubber Eng. & Development	Van Nuys, Calif.
84970	Sarkes Tazian, Inc.	Bloomington, Ind.	93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio	98159	Rubber Teck, Inc.	Gardena, Calif.	000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
85454	Boonton Molding Company	Boonton, N.J.	93788	Howard J. Smith Inc.	Port Monmouth, N. J.				000QQ	Cooltron	Oakland, Calif.
85471	A.B. Boyd Co.	San Francisco, Calif.							000SS	Control of Elgin Watch Co.	Burbank, Calif.
									000WW	California Eastern Lab.	Burlingame, Calif.
									000YY	S.K. Smith Co.	Los Angeles 45, Calif.

# SALES AND SERVICE OFFICES IN THE U.S. AND CANADA

## ALABAMA

Huntsville, 35801  
Hewlett-Packard  
Southern Sales Division  
Holiday Office Ctr., Suite 18  
(205) 881-4591  
TWX: 510-579-2204

## ARIZONA

Scottsdale, 85251  
Hewlett-Packard  
Neely Sales Division  
3009 No. Scottsdale Rd.  
(602) 945-7601  
TWX: 602-949-0111

Tucson, 85716  
Hewlett-Packard  
Neely Sales Division  
232 So. Tucson Blvd.  
(602) 623-2564  
TWX: 602-792-2759

## CALIFORNIA

Los Angeles Area  
Hewlett-Packard  
Neely Sales Division  
3939 Lankershim Blvd.  
North Hollywood 91604  
(213) 877-1282 and 766-3811  
TWX: 910-499-2170

Sacramento, 95821  
Hewlett-Packard  
Neely Sales Division  
2591 Carlsbad Ave.  
(916) 482-1463  
TWX: 916-444-8683

San Diego, 92106  
Hewlett-Packard  
Neely Sales Division  
1055 Shafter Street  
(714) 223-8103  
TWX: 714-276-4263

San Francisco Area  
Hewlett-Packard  
Neely Sales Division  
501 Laurel Street  
San Carlos 94071  
(415) 591-7661  
TWX: 910-376-4390

## COLORADO

Englewood, 80110  
Hewlett-Packard  
Lahana Sales Division  
7965 East Prentice  
(303) 771-3455  
TWX: 303-771-3056

## CONNECTICUT

Middletown, 06458  
Hewlett-Packard  
Yewell Sales Division  
589 Saybrook Rd.  
(203) 346-6611  
TWX: 203-346-7433

## FLORIDA

Miami, 33125  
Hewlett-Packard  
Florida Sales Division  
2907 Northwest 7th St.  
(305) 635-6461

Orlando, 32803  
Hewlett-Packard  
Florida Sales Division  
621 Commonwealth Ave.  
(305) 425-5541  
TWX: 305-275-1234

St. Petersburg, 33708  
Hewlett-Packard  
Florida Sales Division  
410-150th Ave., Madeira Beach  
(813) 391-0211  
TWX: 813-391-0666

## GEORGIA

Atlanta, 30305  
Hewlett-Packard  
Southern Sales Division  
3110 Maple Drive, N. E.  
(404) 233-1141  
TWX: 810-751-3283

## ILLINOIS

Chicago, 60645  
Hewlett-Packard  
Crossley Sales Division  
2501 West Peterson Ave.  
(312) 275-1600  
TWX: 910-221-0277

## INDIANA

Indianapolis, 46205  
Hewlett-Packard  
Crossley Sales Division  
3919 Meadows Dr.  
(317) 546-4891  
TWX: 317-635-4300

## KENTUCKY

Louisville, 40218  
Hewlett-Packard  
Southern Sales Division  
Suite 4, 3411 Bardstown Rd.  
(502) 459-4140  
TWX: 810-535-3128

## MARYLAND

Baltimore, 21207  
Hewlett-Packard  
Horman Sales Division  
6660 Security Blvd.  
(301) 944-5400

Washington, D. C. Area  
Hewlett-Packard  
Horman Sales Division  
941 Rollins Avenue  
Rockville 20852  
(301) 427-7560  
TWX: 710-828-9684

## MASSACHUSETTS

Boston Area  
Hewlett-Packard  
Yewell Sales Division  
Middlesex Turnpike  
Burlington 01804  
(617) 272-9000  
TWX: 710-332-0382

## MICHIGAN

Detroit, 48235  
Hewlett-Packard  
Crossley Sales Division  
14425 West Eight Mile Road  
(313) 342-5700  
TWX: 313-342-0702

## MINNESOTA

St. Paul, 55114  
Hewlett-Packard  
Crossley Sales Division  
842 Raymond Avenue  
(612) 646-7881  
TWX: 612-551-0055

## MISSOURI

Kansas City, 64131  
Harris-Hanson Company  
7916 Paseo Street  
(816) 444-9494  
TWX: 816-556-2423  
St. Louis, 63144  
Harris-Hanson Company  
2814 South Brentwood Blvd.  
(314) 647-4350  
TWX: 314-962-3933

## NEW JERSEY

Asbury Park Area  
Hewlett-Packard  
Robinson Sales Division  
Shrewsbury  
(201) 747-1060

## Englewood, 07631

Hewlett-Packard  
RMC Sales Division  
391 Grand Avenue  
(201) 567-3933

## NEW MEXICO

Albuquerque, 87108  
Hewlett-Packard  
Neely Sales Division  
6501 Lomas Blvd., N. E.  
(505) 255-5586  
TWX: 505-243-8314

Las Cruces, 88001  
Hewlett-Packard  
Neely Sales Division  
114 S. Water Street  
(505) 526-2486  
TWX: 505-524-2671

## NEW YORK

New York, 10021  
Hewlett-Packard  
RMC Sales Division  
236 East 75th Street  
(212) 879-2023  
TWX: 710-581-4376

Rochester, 14625  
Hewlett-Packard  
Syracuse Sales Division  
800 Linden Avenue  
(716) 381-4120  
TWX: 716-221-1514

Poughkeepsie, 12601  
Hewlett-Packard  
Syracuse Sales Division  
82 Washington St.  
(914) 454-7330  
TWX: 914-452-7425

Syracuse, 13211  
Hewlett-Packard  
Syracuse Sales Division  
Pickard Bldg., E. Molloy Rd.  
(315) 454-2486  
TWX: 315-477-1375

## NORTH CAROLINA

High Point, 27262  
Hewlett-Packard  
Southern Sales Division  
1923 N. Main Street  
(919) 882-6873  
TWX: 510-926-1516

## OHIO

Cleveland, 44129  
Hewlett-Packard  
Crossley Sales Division  
5579 Pearl Road  
(216) 884-9209  
TWX: 216-888-0715

Dayton, 45409  
Hewlett-Packard  
Crossley Sales Division  
1250 W. Dorothy Lane  
(513) 299-3594  
TWX: 513-944-0090

## PENNSYLVANIA

Camp Hill  
Hewlett-Packard  
Robinson Sales Division  
(717) 737-6791

## Philadelphia Area

Hewlett-Packard  
Robinson Sales Division  
144 Elizabeth Street  
West Conshohocken 19428  
(215) 248-1600 and 828-6200  
TWX: 215-828-3847

## Pittsburgh Area

Hewlett-Packard  
Crossley Sales Division  
2545 Moss Side Blvd.  
Monroeville 15146  
(412) 271-5227  
TWX: 710-797-3650

## TEXAS

Dallas, 75209  
Hewlett-Packard  
Southwest Sales Division  
P.O. Box 7166, 3605 Inwood Rd.  
(214) 357-1881 and 332-6667  
TWX: 910-861-4081

## Houston, 77027

Hewlett-Packard  
Southwest Sales Division  
P.O. Box 22813, 4242 Richmond Ave.  
(713) 667-2407  
TWX: 713-571-1353

## UTAH

Salt Lake City, 84115  
Hewlett-Packard  
Lahana Sales Division  
1482 Major St.  
(801) 486-8166  
TWX: 801-521-2604

## VIRGINIA

Richmond, 23230  
Hewlett-Packard  
Southern Sales Division  
2112 Spencer Road  
(703) 282-5451  
TWX: 703-282-9986

## WASHINGTON

Seattle Area  
Hewlett-Packard  
Neely Sales Division  
11656 N. E. 8th St.  
Bellevue 98004  
(206) 614-3971  
TWX: 910-443-2303

## CANADA

Montreal, Quebec  
Hewlett-Packard (Canada) Ltd.  
8270 Mayrand Street  
(514) 735-2273  
TWX: 610-421-3484

Ottawa, Ontario  
Hewlett-Packard (Canada) Ltd.  
1762 Carling Avenue  
(613) 722-4223  
TWX: 610-562-1952

Toronto, Ontario  
Hewlett-Packard (Canada) Ltd.  
1415 Lawrence Avenue, West  
(416) 249-9196  
TWX: 610-492-2382

HEWLETT  PACKARD

# INTERNATIONAL SALES AND SERVICE OFFICES

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Telecomunicaciones  
Carlos Calvo 224, Buenos Aires  
Tel: 30-6312

## AUSTRALIA

Sample Electronics (Vic.) Pty. Ltd.  
9-11 Cremorne Street  
Richmond E. 1, Victoria  
Tel: 42-4757 (3 lines)  
Sample Electronics (N.S.W.) Pty. Ltd.  
4 Grose Street, Glebe, Sydney  
New South Wales  
Tel: 69-6338 (6 lines)

## AUSTRIA

Unitlabor G.m.b.H.  
Rummelhardtgasse 6/3  
Vienna  
Tel: 426.181

## BELGIUM

Hewlett-Packard Benelux S.A.  
20-24 Rue de l'Hopital, Brussels  
Tel: 11.22.20

## BRAZIL

Ciental Importacao E Comercio Ltda.  
Rua Cons. Crispiniano, 69, 8. ° And.,  
Conj. 81, Sao Paulo  
Tel: 32-4332

## CANADA

Hewlett-Packard (Canada) Ltd.  
8270 Mayrand Street  
Montreal, Quebec  
(514) 735-2273  
Hewlett-Packard (Canada) Ltd.  
1762 Carling Avenue  
Ottawa, Ontario  
(613) 722-8162  
Hewlett-Packard (Canada) Ltd.  
1415 Lawrence Avenue W.  
Toronto, Ontario  
(416) 249-9196

## CHILE

Hector Calcagni  
Casilla 13942  
Santiago  
Tel: 6.42.26

## DENMARK

Tage Olsen A/S  
Ronnegade 1  
Copenhagen Ø  
Tel: 29.48.00

## FINLAND

INTO O/Y  
P. O. Box 153  
Meritutlinkatu 11, Helsinki  
Tel: 66.39.09 and 35.125

## FRANCE

Hewlett-Packard France  
150 Boulevard Massena  
Paris 13e  
Tel: 707.97.19

## GERMANY

Hewlett-Packard V.m.b.H.  
Steindamm 35, Hamburg  
Tel: 24.05.51  
Hewlett-Packard V.m.b.H.  
Kurfürststrasse 95  
Frankfurt am Main  
Tel: 52.00.36

Hewlett-Packard V.m.b.H.  
Reginfriedstrasse 13  
Munich 9  
Tel: 49.51.21/22  
Hewlett-Packard Vm.b.H.  
Technisches Büro  
Herrenbergerstrasse 110  
703 Böblingen, Württemberg  
Tel: 6971

## GREECE

K. Karayannis  
Klaffmonos Square, Athens 124  
Tel: 230.301 (5 lines)

## INDIA

The Scientific Instrument Company, Ltd.  
6, Tej Bahadur Sapru Road, Allahabad 1  
Tel: 2451  
The Scientific Instrument Company, Ltd.  
240, Dr. Dadabhai Naoroji Road,  
Bombay 1  
Tel: 26-2642  
The Scientific Instrument Company, Ltd.  
11, Esplanade East, Calcutta 1  
Tel: 23-4129  
The Scientific Instrument Company, Ltd.  
30, Mount Road, Madras 2  
Tel: 86339  
The Scientific Instrument Company, Ltd.  
B-7, Ajmeri Gate Extn., New Delhi 1  
Tel: 271053

## IRAN

Telecom Ltd.  
P. O. Box 1812, Tehran  
Tel: 43850, 48111

## ISRAEL

Electronics & Engineering Ltd.  
16 Kremenetski St., Tel Aviv  
Tel: 35021 (3 lines)

## ITALY

Hewlett-Packard Italiana S.p.A.  
Viale Lunigiana 46, Milan  
Tel: 69.15.84/5/6  
Hewlett-Packard Italiana S.p.A.  
Piazza Marconi, 25  
Roma-Eur  
Tel: 59.25.44/5

## JAPAN

Yokogawa-Hewlett-Packard Ltd.  
2270 Ishikawa-cho  
Hachioji, Tokyo  
Tel: Hachioji 0426-3-1231 (19 lines)  
Yokogawa-Hewlett-Packard Ltd.  
No. 3, 6-chome, Aoyama-Kitamachi  
Akasaka, Minato-ku, Tokyo  
Tel: 403-0073, 403-0074, 403-0075  
Yokogawa-Hewlett-Packard Ltd.  
No. 8, Umeda, Kita-ku, Osaka City  
Tel: 361-3084, 341-2095  
Yokogawa-Hewlett-Packard Ltd.  
No. 4, 3-chome, Himeikadori,  
Chigusa-ku, Nagoya City  
Tel: 75-8545

## KOREA

American Trading Company, Korea, Ltd.  
112-35 Sokong-Dong  
Seoul P. O. Box 1103  
Seoul  
Tel: 3-7049, 3-7613

## NETHERLANDS

Hewlett-Packard Benelux N.V.  
23 Burg Roelstraat, Amsterdam W.  
Tel: (020) 13.28.98 and 13.54.99

## NEW ZEALAND

Sample Electronics (N. Z.) Ltd.  
8 Matipo Street  
Onehunga S. E. 5, Auckland  
Tel: 565-361

## NORWAY

Morgenstjerne & Co. A/S  
Ingeniørfirma  
6 Wessels Gate, Oslo  
Tel: 20 16 35

## PORTUGAL

Telectra  
Rua Rodrigo da Fonseca 103  
P. O. Box 2531  
Lisbon 1  
Tel: 68 60 72 and 68 60 73 and 68 60 74

## PUERTO RICO & VIRGIN ISLANDS

San Juan Electronics, Inc.  
150 Ponce de Leon, Stop 3  
P. O. Box 5167  
Pta. de Tierra Sta., San Juan 00906  
Tel: 722-3342, 724-4406

## SPAIN

ATAIO, Ingenieros  
A. Aguilera, No. 8, Madrid 15  
Tel: 223.27.42, 223.41.71, and 224.84.97

## SOUTH AFRICA

F. H. Flanter & Co. (Pty.), Ltd.  
Rosella House  
Buitencingle Street, Cape Town  
Tel: 3-3817

## SWEDEN

H-P Instrument AB  
Centralvagen 28, Solna Centrum  
Tel: 08-83.08.30 and 10-83.08.30

## SWITZERLAND

Max Pual Frey  
Wankdorffeldstrasse 66, Bern  
Tel: (031) 42.00.78

## TAIWAN (FORMOSA)

Hwa Sheng Electronic Co., Ltd.  
21 Nanking West Road, Taipei  
Tel: 4-6076, 4-5936

## TURKEY

TELEKOM Engineering Bureau  
P.O. Box 376—Galata, Istanbul  
Tel: 49.40.40

## UNITED KINGDOM

Hewlett-Packard Ltd.  
Dallas Road  
Bedford, England  
Tel: Bedford 68052

## VENEZUELA

Citec, C. A.  
Edif. Arisan-Of #4  
Avda. Francisco de Miranda-Chacaito  
Apartado del Este 10.837, Caracas  
Tel: 71.88.05

## YUGOSLAVIA

Belram S.A.  
83 Av. des Mimosas  
Brussels 15, Belgium  
Tel: 35.29.58

For Sales and Service Assistance in Areas Not Listed Contact:

## IN EUROPE

Hewlett-Packard, S. A.  
54 Route des Acacias  
Geneva, Switzerland  
Telephone: (022) 42.81.50  
Telex: 2.24.86  
Cable: HEWPACKSA

## IN LATIN AMERICA

Hewlett-Packard Inter-Americas  
1501 Page Mill Road  
Palo Alto, California 94304, U.S.A.  
Telephone: (415) 326-7000  
TWX: 910-373-1267  
Telex: 033811 Cable: HEWPACK

## ELSEWHERE

Hewlett-Packard  
International Marketing Department  
1501 Page Mill Road  
Palo Alto, California 94304, U.S.A.  
Telephone: (415) 326-7000  
TWX: 910-373-1267  
Telex: 033811 Cable: HEWPACK